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THE

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THE TRAMWAY DEADLOCK.

GREAT is the debt to Science of modern Engineering; greater still the debt of Electrical Engineering, the child of Science, and it would be a sorry sight to see the child rebel against his parent. Yet at the present time a deadly struggle, fraught with momentous issues to millions of the inhabitants of London, is being carried on between the pioneers of electric tramway enterprise in the metropolis and the official seekers after truth.

The apparent anomaly, however, is easily explained. It is not Science, but *scientists*, that block the path of progress. That Science never did, though many wrongs have been wrought in her name.

The state of affairs in the West-end is well shown by the official report of the conference held at the Board of Trade offices on October 31st, under the presidency of Sir Courtenay Boyle, whose perfect fairness and evident desire to arrive at a satisfactory solution of the question were beyond praise. Mr. Trotter reported that a scheme had been put forward by the London United Tramways Company, according to which, by means of a special system of feeding and boosting the line in isolated sections of one mile each, it was proposed to keep down the potential difference between the rails and earth, within two miles of Kew Observatory, to a maximum of 0·2 volt. At a greater distance from the Observatory a maximum of 1 volt was suggested. Mr. Glazebrook decided that the scheme, which was drawn up by Mr. Parshall, would in all probability afford sufficient protection to the Kew laboratories; but he could not assert that the protection would be complete. At a later date the Tramways Company proposed several new lines in the neighbourhood of Kew; the authorities could not guarantee that the proposed remedy would be efficacious, the engineers protested that under these conditions it was unreasonable to expect them to incur a heavy, and perhaps futile, expenditure, and things came to a standstill.

Now, as soon as the lines were sufficiently advanced for the purpose, the tramway engineers tested the potential difference between points on the lines, and found it to be no less than 0·8 volt, although the lines were idle. As Mr. Parshall pointed out, the proposed regulations would thus "debar the use of rails in the earth at all, quite apart from electrical working." Further experiments made by Mr. Parshall with a magnetometer of the Kew type, placed near the Observatory, showed that even when heavy currents were passed through the line the disturbance was negligible at Kew.

The cost of the proposed scheme was estimated at £40,000, as regards the London United Tramways Company's undertaking. Not only would this initial outlay be required, but the number of cars would have to be reduced by 50 per cent., and the holiday traffic to Hampton Court would be crippled. Further, having in view the high potential difference already

D

met with in the line, it would be necessary to enforce similar conditions upon the existing and projected underground electric railways, the former of which are suspected to be the cause of the phenomenon. The conditions which the Observatory authorities sought to impose were, in fact, preposterous, and could not possibly be accepted.

Mr. Parshall inquired, in this connection, whether the effect of existing undertakings (which caused the 0·8 volt drop in the line) had already been observed at Kew, and drew forth the remarkable admission that Mr. Glazebrook had not "accurately compared the curves lately," but was not aware that there was anything in them to interfere with the comparisons that had previously been made. Are we to understand that these priceless curves are merely recorded to put away in a pigeon-hole? Such things, we know, are done in *some* Government departments. On the other hand, if they had been examined and no abnormality discovered, on what grounds does the Observatory continue to block progress? The P.D. observed is quadruple the limit suggested.

Mr. Clifton Robinson stated that if the double-trolley system were adopted, there would be no fewer than 13 trolley wires at one point of the overhead construction—a sufficiently awful prospect, especially with the three-wire system at 1,000 volts between the outers! As for the conduit system, apart from the prohibitive expense, Major Cardew pointed out that the wholly insulated system is a chimera; in New York faults constantly occur, such as would inevitably cause as much magnetic disturbance as the earth return of a trolley line. Moreover, is it possible by the use of the most perfect insulation to efficiently protect magnetic observatories? The paper read by Prof. Rücker before the Physical Society on Friday last, an abstract of which will be found elsewhere in this issue, comes at a most opportune moment in this connection.

Prof. Rücker states that the earth currents affect the horizontal component only, while the magnetic field created by the current flowing out through the feeders, and returning by the rails, affects the vertical component; he goes on to say that the instruments used for testing the *vertical* component are those which are chiefly affected.

In other words, the question of insulating or not insulating the return is of less consequence than the arrangement of the lead and return conductors in such a manner as to minimise the magnetic field produced by the currents flowing in them. The results of tests made at Stockton by the Observatory authorities, on the offer of the tramway engineers, showed a disturbance of 0·00007 C.G.S. units in the vertical component—the magnitude of which is about 0·44.

Let us now see what all the trouble is about. There are at Kew, amongst a large number of other apparatus, certain instruments for measuring and recording the elements of terrestrial magnetism. Of these, the recording instruments are chiefly concerned. The value of their records lies in the fact that they have been continuously kept for a long period of years, and that if they were removed to another place the continuity of the record would be destroyed. As to the actual results obtained, as the outcome of this secular experiment, it has been claimed by the Astronomer Royal that they are very "interesting," and have something to do with sun-spots, which, again, have something to do with the weather; he admitted, however, when pressed by Sir Courtenay Boyle, that while "interesting results" were got from a comparison of the records of Kew and Greenwich, the comparison was a matter of secondary importance; the work at Greenwich was indispensable, but that at Kew consisted largely of the verification of instruments. Seeing that so short a distance intervenes between the two Observatories, it is difficult to see the importance of a comparison of their records; and as the work has been carried on for a longer period at Greenwich than at Kew, even the magneticians, who lay such stress on continuity, must admit that it were better to lose Kew than Greenwich.

Prof. Rücker endeavoured to establish the importance of Kew as the mainstay of the instrument making industry of this country! Instruments are ordered from abroad with the proviso that they must be tested at Kew; £4,000 worth of magnetographs have been supplied, in what period was not stated. The Professor hinted at the extinction of the trade—presumably as a consequence of stopping the magnetic records at Kew! Another point was that at Kew magneticians from all over the world are trained.

It is necessary to add that Mr. Glazebrook, in a letter, remarked that if the protection scheme failed it might "be necessary to consider the alternative of removing the recording instruments to some completely isolated position."

We need not point out that the case for Kew is of the weakest—almost frivolous, compared with the vast commercial interests involved; a careful perusal of the official report which lies before us is still more convincing.

So well aware of this fact are the supporters of the magnetic records, that some of them have resorted to the device which is commonly known as trailing a red herring across the path. That is, they have raised the bogey of *electrolysis!*

What in the world has electrolysis to do with magnetic observations?

The magneticians no doubt hope by dragging in this side issue to raise up unto themselves many powerful allies. They deceive themselves. So far from strengthening their case, they have by this course confessed its weakness. How little ground there is for apprehensions of this nature has been well shown, if proof were wanting, by M. Claude in his paper on the same subject before the Société Internationale des Electriciens last June, in which he demonstrated that with low potential differences, *i.e.*, of the order 2 or 3 volts, not only was the proportion of current returning by water and gas pipes far less than was previously supposed, but that the great bulk of the earth current was conveyed by quasi-metallic conduction, the loss of weight of the surfaces which acted as electrodes being but a small percentage of its theoretical value. These statements are confirmed by Mr. Herrick in the United States, who has conducted similar experiments.

In this connection, we wish to enter an emphatic protest against certain statements embodied in a recent article in *Nature*, entitled "Electric Traction Troubles," in which nonsensical calculations and deductions are made; but space will not permit of further reference to this matter.

In conclusion, it appears to us that there is but one satisfactory solution of the difficulty. Let the tramways commence working (they are quite ready) at once. *If*—and it is open to question—if the records at Kew are spoilt, let them go; but let most perfect safeguards be adopted at Greenwich, where no such important scheme is in hand, and where the work is vastly more important than at Kew.

The Direct Current Arc.

Last Thursday at the Institution of Electrical Engineers there was read another contribution from Prof. Ayrton's laboratory to our knowledge of the arc. We print part of Mr. Duddell's paper in another part of this issue, and believe that it will attract very great interest and attention. There seems to be no end to the discoveries of unexpected phenomena in this direction, and those just described by Mr. Duddell are singularly interesting, and promise to be of great practical importance. The fact that it is not possible to strike an arc from metal rods when these are connected to the two terminals of a condenser is not altogether new. A condenser has often been employed to reduce the spark on breaking a contact, and the use of a condenser connected across the interrupter of an inductance coil is commonly explained in this way. So the fact, that an arc between an iron rod and a vessel of water cannot be struck if a condenser is con-

nected across them has been observed, though we do not know that it has been published or commented upon. The statement of the general fact, that metallic arcs cannot be struck under these conditions, is however, we believe, Mr. Duddell's. That there is a very great difference between the P.D. of a pair of metal rods when separated with and without a condenser appears to be a new observation, and one of great practical significance. Mr. Duddell points out its bearing on the question of breaking a current in a conductor having capacity, such as a concentric cable, by means of an ordinary metal switch, and suggests that the use of carbon points for the final break may be an important provision for the protection of the line, in addition to the saving effected in the metallic contact surfaces. The improvement of induction coils by connecting the condenser to the interrupter immediately after the break, instead of keeping it constantly connected, is very remarkable, though the experiment was less striking than some of the others. In the discussion which followed, Prof. Ayrton mentioned that in one laboratory experiment the action of the coil had been improved by as much as five to seven times by making the connection to the condenser in this way. This is, of course, an enormous improvement, and may have a large field open to it in practical work. Every one knows by experience that an arc may be unpleasantly noisy, and the fact that it gives out sounds corresponding to disturbances in its circuit, such as the passage of the commutator bars under the dynamo brushes, has been repeatedly observed. Mr. Duddell's demonstration, however, of its remarkable sensibility to such small disturbances as are possible in telephony, was very striking.

The cream of the paper was undoubtedly the experiments showing the ability of an arc, and especially of a cored carbon arc, to maintain electrical oscillation in a circuit with a period determined only by its capacity, self-induction, and resistance; and independent of the conditions of the arc itself. The determination of the conditions which must be satisfied in order that such a result should be possible brought Mr. Duddell directly to the result obtained in 1895 by Frith and Rodgers, which became famous, or infamous, through the startling mode in which it was announced; viz., that the arc has negative resistance. As a practical result, Mr. Duddell has placed in our hands a ready and convenient means of maintaining steady oscillations of large amplitude of a period which is the natural period of the circuit itself, much as the lips or a reed are able to maintain steady vibration in the tube of a wind instrument. The process appears to be much more convenient for many purposes than the use of a motor running at a known speed, or of an electrically-driven tuning fork, on account of the simplicity of the apparatus, and the ease with which the frequency can be adjusted to any desired figure, and instantaneously altered. The clear indication given by the note of the arc of the actual period at each instant would be very convenient in many cases. The performance of the National Anthem on the arc was a happy mode of ending the lecture.

Mr. Duddell's paper is peculiarly interesting for several reasons. When new phenomena can be connected to those previously known, by the explanation of their action, the addition made to our knowledge is much greater than in the case of isolated facts, and the discovery of the capacity of the arc to maintain electric oscillations is the more valuable, because it might have been predicted from the result of Messrs. Frith and Rodgers. These experiments seem to bear on the curious action of currents interrupted in the body of a liquid as in Wehnelt's interrupter, and in the case referred to above of an arc struck between a metal rod and a pan of water. There is evidently very much more to be found out, and we hope that Mr. Duddell may have more to tell us before long on the subject which appears to have been immediately before him, when he obtained the facts of this last paper, viz., the effect of rapid alternations imposed on a direct current arc.

SOME NOTES ON THE DESIGN OF LARGE ALTERNATORS.*

By A. HEYLAND.

(*Concluded from page* 932.)

Alternator No. 2.—Fig. 9 shows the no load characteristic of this machine. In order to get the terminal pressure of 2,200 volts per phase at no load an excitation is required of 137 amperes (at 80 volts); in this machine the saturation

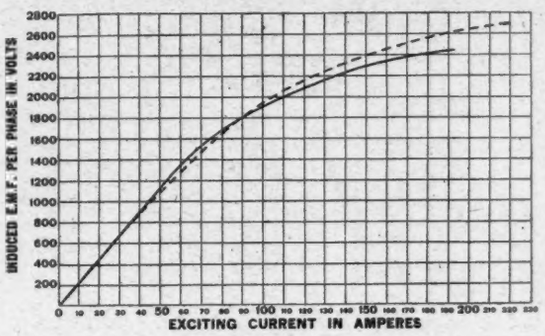


Fig. 9.

of the iron has been carried even farther than with Alternator No. 1, as will be noticed, if the two curves are superimposed upon one another. The short-circuit curve is given by fig. 10, from which it will be seen that an excitation of

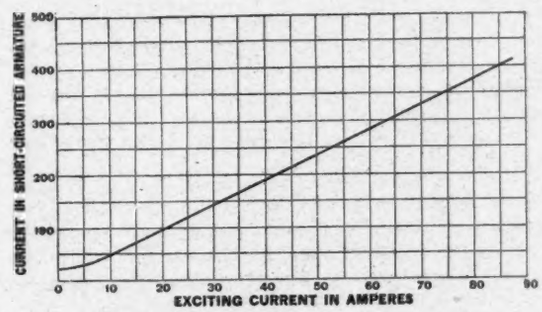


Fig. 10.

43 amperes is necessary when the armature current is 200 amperes per phase.

With this alternator, the leakage flux of the armature, when the current in the latter is 200 amperes per phase, is represented by 230 volts. The diagrams given in figs. 11 and 12 show the fall of pressure; they have been drawn out in exactly the same manner as those for Alternator No. 1. The results are as under :—

Power-factor.	Fall of pressure.
0·85	10·5 per cent.
1·0	4 „

The two drops would have been 20 per cent. and 8 per cent. respectively if the poles had not been saturated.

The results confirm those obtained with Alternator No. 1, and are exceedingly good when the small excitation of the machine is considered. The relation between field ampere-turns and armature ampere-turns, or what is the same thing, the relation between the short-circuit current and the full load current, is a ratio which is fairly constant for given types of alternators; it is an exceedingly useful constant, as it enables designers to compare the quality of an alternator with regard to pressure drop. For good machines as usually constructed, this constant lies between 4 and 5, whereas in the two alternators tested as above described it has a value of only 3·2. The dimensions of a machine for a given output depend very greatly upon the above constant, a fact well

* These notes have special reference to tests made on the alternators of 1,000 E.H.P., exhibited by The Electricité et Hydraulique, Limited, of Charleroi at the Paris Exhibition.

known and appreciated by experienced designers. The fact of the constant being so small in the writer's machines has led him to the conclusion that by applying the principles of design described here, it would be possible to increase greatly the output of a generator of standard dimensions. The output of an alternator increases proportionately with the ampere-turns on the armature, and as these windings occupy

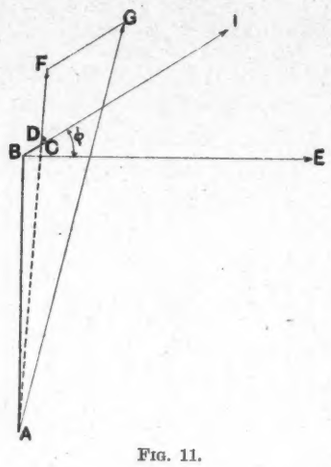


Fig. 11.

relatively but little room, the increase of winding space necessary for the larger output can be attained by increasing the size of the slots; at the same time the pressure drop (the factor determining the output of iron-cored armatures) will be normal on account of the high saturation of the magnetic system.

The dimensions of the two alternators considered above are perfectly normal, as it would not have been advisable to have experimented with such large units. But with generators of smaller dimensions the writer has recently obtained results which entirely confirm his ideas. For instance, a normal generator of 100 KW. has been taken, and reconstructed in accordance with the principles set forth above; it was found that the new rating could be perfectly safely taken to be 200 KW., as with this output the efficiency and temperature rise were entirely satisfactory, and the increase of excitation necessary from no load to full load quite normal. The armature of this generator (three-phase) was 35·5 inches in diameter and 9·5 inches in width, the speed

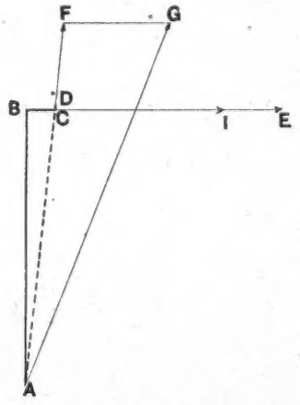


Fig. 12.

being 500 revolutions per minute. Thus at 100 KW. output, the constant connecting output, speed and dimensions (watts $= D^2 L n \times K$), works out to be 0·0166 in inch units, which is a normal value for standard machines of ordinary construction of this size. But the alteration of the magnetic quantities in accordance with the principles put forward above, rendered an output of double the above rating possible (for the same efficiency and heating), doubling, therefore, the value of the constant.

To sum up then, we see that the principle of designing alternators with abnormally high flux densities in the field system possesses two great advantages; it greatly reduces the pressure drop, and it enables the rating of a standard carcase to be increased. As soon as the advantages of this method of construction become more widely known, it is certain that the principles set out above will be generally adopted, on account of the important bearing they have on the commercial aspect of alternator design.

TEST OF A 300-KW. STEAM ALTERNATOR.

By N. APPELBEE, Electrical Engineer, Cardiff.

Below are given the results of a steam consumption test made on a 300-KW. steam alternator supplied recently by Messrs. Ferranti, of Hollinwood, to the order of the Cardiff Corporation.

The figures are sufficiently good to interest your readers, and the names of the gentlemen who conducted the tests are a guarantee of their reliability and accuracy.

The plant comprises a vertical compound condensing engine, having cylinders 18 inches and 34 inches × 18 inches, with an alternator of Ferranti's well-known copper armature type between the H.P. and L.P. engines, the whole designed to give 300 KW., 2,500 volts × 120 amperes, 40 periodicity at 200 revolutions per minute. The valves are of the gridiron type, driven by cam gear, the governing being effected by a throttle valve, and there is forced lubrication. The alternator drives its own exciter.

The test was made on November 18th, 1899, there being present as experts on behalf of Messrs. Ferranti, Mr. M. Longridge, Mr. A. B. Mountain and Mr. Gillett. On behalf of the Cardiff Corporation, there were Mr. H. R. J. Burstall and Mr. Llewelyn B. Atkinson. The test was started at 9.15 a.m. and continued at full power until 4.12 p.m.

The steam from the engine was discharged into a surface condenser which received the steam of this engine only. The air pump discharge was measured by being run into two barrels, one being filled while the other was being emptied, each being filled up to a mark. During the trial 69 pairs of barrels were used, making a total of 53,030 lbs. The next day a test was made to ascertain whether the condenser was tight, and it was found that a leak equal to 1 per cent. existed, making the total water used equal 52,500 lbs. It was found that 92 lbs. of water had collected in the drain sump under the engine (having escaped from the glands), which has to be added, making a final total of 52,592 lbs. The duration of the trial being 6·95 hours, the quantity of steam used by the engine was 7,568 lbs. per hour.

The vacuum, as measured in the exhaust pipe close to the engine, was 18·7 inches, or 9·2 lbs. per square inch.

The alternator was run on a water resistance; the power was measured by a number of ammeters and voltmeters, one of each being chosen, after comparison with a Kelvin watt-balance, as being the most accurate, and readings were taken every 15 minutes. There was also a Thompson recording voltmeter, which was read every 30 minutes.

Each of the instruments read during the trial was sent to the Board of Trade laboratory, immediately after the trial, for calibration, and the necessary corrections have been made in the calculations. The mean output of the alternator was 315 KW.

The mean H.P. shown by the indicator cards was 499 at the mean speed of 204·9 revolutions per minute, as got from the engine counter.

The combined efficiency of the engine and alternator, taking the above figures for electrical output and indicated horse-power, was 84·6 per cent.

Taking the figures actually obtained, the steam per KW.-hour was 24·03 lbs., being practically 2 lbs. below that allowed by the specification.

I think this is very good; and if the vacuum had been 26 or 27, the result would, of course, have been materially better.

No special preparations were made to prepare the engine for this test. The steam was supplied from boilers of the dry-back marine type, and was not superheated.

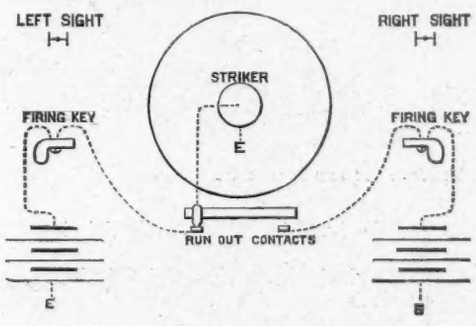
NAVAL GUN CIRCUITS.

The advantages that are obtained by using electricity for firing guns in the Navy are twofold. First and foremost is the increased safety; for with its electric circuit broken until the gun is run out, a gun can only be fired in a safe position, and the fuse, or tube as it is called, containing no fulminate of mercury, allows of rough handling of the cartridge, which under the circumstances that attend a rapid and continual fire is inevitable, or practically so. The second advantage is in the position of the captain of the gun, who can keep his eye along the sights and his finger on the trigger the whole time the gun is being loaded, so that he is ready to lose no time directly the gun is out again.

In percussion firing, which is always an alternative in case of the electric circuit failing, the lanyard that releases the striker is not in the hands of the captain of the gun himself it is pulled by a subordinate on the word "Fire!" When the movement of the ship is considered, together with the motion of the target, the fraction of time that elapses between the word of command and its execution makes no small difference to the practice.

A reference to the accompanying diagram will show how the circuit is arranged in the 6-inch quick-firing gun. The sights are fixed on the mounting, and not on the gun itself, which, by its recoil, would otherwise force the captain of the gun to take a fresh alignment each round. There are two sets of sights, one on either side, two batteries, and naturally two distinct firing keys, which are in the form of a pistol, the trigger making contact on being pressed.

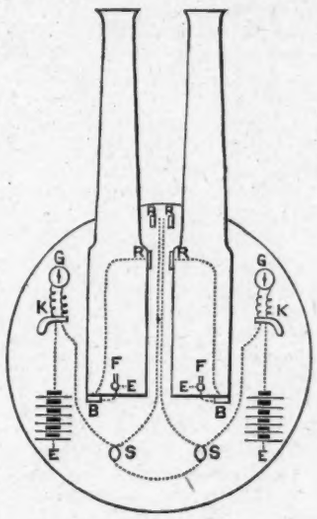
The circuit in each case may be traced from the negative pole of the battery through the firing key to a rubbing contact at the outer extremity of the recoil slide; a contact



6-inch Q.F. Gun Circuits.

piece on the gun itself takes against this when the gun is fully run out, and only then is the circuit complete to the striker. The striker, so called from the fact that it is made to do duty as such when percussion fire is resorted to, consists of a steel tube filled with gutta-percha insulation, through the centre of which runs the circuit, ending in a brass nipple, which takes against the contact piece on the fuse itself when the breech is closed. A mechanical device on the breech prevents this nipple from making contact until the breech-piece is properly home, so that it would be impossible to fire the gun with the breech only partially in position. The nipple makes contact with a small disc that is well insulated from the brass cartridge into which the fuse is screwed, and the circuit proceeds from this disc to a thin platinum bridge embedded in priming composition and thence to earth, which is represented by the brass cartridge case and the gun. The positive pole of the battery being brought to the gun mounting picks up the return through the gun. Now, it will be seen that no dangerous premature explosion can take place, even through the greatest carelessness. In the excitement attendant on gun practice, details of the drill-book are sometimes overlooked, and however well trained a man may be, he is not infallible, as the occasional accidents that have occurred in times past go to show.

It may be argued that mechanical means can be provided to prevent the striker from being released, in the case of percussion firing, until the gun is in a safe condition, and that



Turret Circuits, 12-inch B.L. Guns.

electric circuits have the disadvantage of giving out on small provocation; this is true, but hitherto it has been found very hard to devise a percussion lock that will withstand sufficient wear and tear to be absolutely reliable. With electricity, if there is a failure it is on the safe side, for it simply results in the gun not going off at all.

The turret or barbette circuits in battleships of the later types, such, for instance, as the *Majestic* class, serve as a very good illustration of the precautionary measures that are provided to insure against accidental firing of the gun when in an unsafe position, or before the breech is properly closed.

The safety arrangements may be divided into four, namely, the firing key, the rear switch, the run-out contact and the breech-locking bolt. If we trace the circuit in the accompanying diagram, we shall see that it is in duplicate, one battery being placed on each side of the turret, and the connections between each battery and its individual gun exactly similar. Thus, in either case we start from the negative pole of the battery and come first to the firing key. This key or pistol is represented in the figure at K, and it is placed in the sighting hood from which the captain of the gun lays his sights.

The circuit is seen to continue from K to the rear switch S.

The rear switch has two duties to fulfil, the most important being the safety it provides for the man whose duty it is to place the fuse or tube in the gun. If this switch is at "off" it is obvious that the tube cannot be fired while the man is immediately in rear of it, and thus cause, by the recoil of the gun, the death of the man attending the breech mechanism; it is under his control, and he only puts it to

"on" when he is in a safe position immediately before the gun is reported ready.

From this switch the circuit proceeds to R, the run-out contact. This contact is made by the gun itself, automatically, upon reaching the limit of its run-out position so that in case of the gun not being properly run out to its full extent it will be impossible to fire it. Were this safety arrangement not there, the gun might be fired when only half out. Its recoil would then be only partially absorbed by the hydraulic cylinders, and disastrous consequences might ensue; in any case there would be a heavy strain brought upon the mounting. From this contact we now come to the fourth and last safety arrangement, which is the breech-locking bolt B.

The breech-locking bolt provides against the gun being fired when the breech is not properly closed, and in order to explain its action it will be necessary first to examine the means by which the breech is screwed home.

After the gun has been loaded, a cradle, in which rests the breech piece, is moved over by a hydraulic ram until it is opposite the chamber. A second ram then pushes it from the rear into the gun.

So far the breech piece is not locked in any way, and it is not until the gun begins to run out that a projection on the breech piece, taking in an inclined slot on the carriage, forces it to revolve within the chamber and the screw threads to take. Until the breech has performed nearly a quarter of a turn, it is not properly home and the gun is not safe. To provide against the possibility of the gun being fired without the breech being properly and securely closed, this fourth safety device is designed. It consists of a locking bolt which works on an inclined plane as the gun runs out, and the circuit is passed through this bolt, insulated from it, of course, so that when the bolt locks the breech piece to the gun the fact of its coming into position completes the circuit.

The circuit proceeds then from the locking bolt direct through the contact piece on the gun tube, thence through the fine fusible bridge embedded in priming composition, and thence to the brass body of the gun tube, where it picks up an earth return in the metal of the gun itself; the positive pole of the battery being led to earth.

With the circuit as at present described, it will be seen how either battery may be made to fire its own particular gun; but in practice it is often necessary to fire both guns simultaneously.

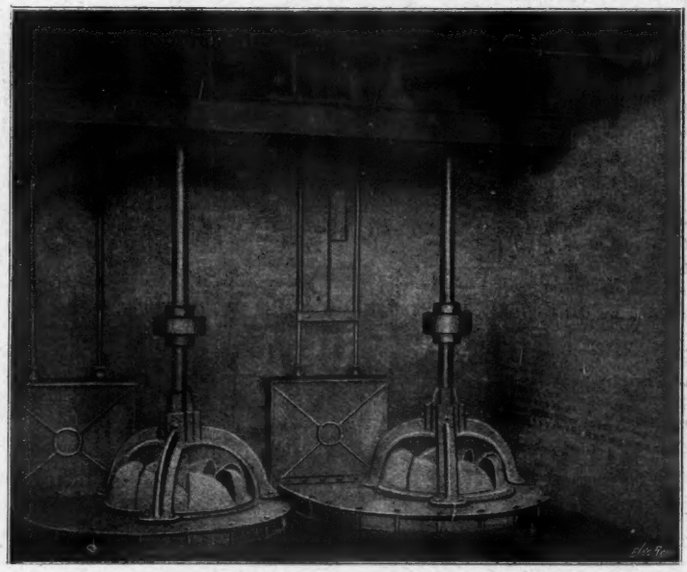
The captain of the barbette or turret usually takes up his position in one of the sighting hoods, and lays both guns from that position—it would cause waste of valuable time if he had to change his position for each gun—and so the two circuits are connected together by a wire between the two switches S. It will now be seen that either battery may be made to fire the guns singly, or both guns simultaneously, according to the connection made by the switch at S, so that if either battery fails the other may be substituted.

A vertical galvanometer, offering a resistance of 1,000 ohms, can be switched into the circuit in place of the firing key immediately before the gun is fired, and this will show if the circuit is complete. Its high resistance renders the current too small to fire the fuse, and thus the circuit may be tested when the gun is loaded.

ELECTRIC LIGHTING OF FLADBURY.

This is an instance of a small village in Worcestershire, situated on the banks of the historic Avon between the towns of Evesham and Pershore, where the main street and some of the principal houses are lighted by electricity at a nominal cost. The scheme is the result of the enterprise of a few commercial men whose object was to have a scheme of lighting, at the same time efficient and profitable.

The complete contract was carried out by Messrs. Young and Co., manufacturing electrical engineers, of Birmingham. The generating station is situated at the Fladbury floor mill, which was formerly supplied with power by a water wheel; this has been removed, and in its place have been fixed two double horizontal 40-inch British Empire turbines in self-contained cases, with vertical gates and gate boxes built into a bulkhead wall. The turbines, of which we give a view, are actuated by a fall of 5 feet 6 inches to 6 feet, and under ordinary conditions are capable of developing 20 H.P. each. The vertical turbine shafts are fitted with cast-iron morticed bevel wheels, with dry hard wood cogs, geared to two cast-iron pinions on a horizontal steel shaft capable of transmitting the whole of the 40 H.P. The main shaft is provided at one end with a pulley, which by means of a belt is connected with a lay shaft fixed in the dynamo room, from which the dynamo is driven. A friction coupling is fixed on the main shaft between the two turbines, in such a manner that the turbines can be run either singly or coupled at will. The other end of the shaft passes through the mill wall, and is there connected to the gear driving the mill machinery. The dynamo room is built on steel girders, immediately above the turbines, and at a sufficient elevation to be out of reach of the floods. The gearing is so arranged that either or both turbines may be used to drive either the dynamo or the mill, or the dynamo and mill may be driven separately at varying speed as required; by this



Turbine Pit and Sluice Gates.

arrangement the risk of interruption to the light is very much lessened.

At present a single dynamo is employed with a two-wire system, but it is intended at an early date to put down a second dynamo and adopt the three-wire system.

The dynamo is of Messrs. B. Young & Co.'s manufacture, constructed to give a normal output of 80 amperes at 220—250 volts, and over-compounded to allow for the drop in voltage in the mains at full load. It is of the two-pole, smooth core, drum type with automatic ring lubrication. The mains are lead-covered and double steel armoured, being buried directly in the ground; the services are derived from junction boxes, each joint being made in a separate box by means of gun-metal clamps, after which the boxes are filled with melted bitumen.

The total distance from the station to the farthest lamp is 630 yards, but the centre of distribution is about 450 yards from the central station, and the total number of lights at present installed is equivalent to 500 lamps of

8 c.p. The dynamo is so over-compounded that a steady pressure of 220 volts is maintained at the centre of distribution, so that the rise in voltage at the near side, or the fall at the far side, may practically be ignored.

THE COMPANIES' ACT, 1900.

I.

Of all the statutes passed in 1900, the Companies' Act, which comes into force on January 1st, is by far the most important to commercial men. The result of long deliberation on the part of the Legislature, it effects drastic changes in the law of joint stock companies, and bids fair to protect the cautious investor from many of the frauds which in recent years have rendered the use of the term company promoter not altogether complimentary. The words "cautious investor" are used advisedly, for no Act of Legislation, however carefully drafted, can protect the fool against his own folly; the bogus company will continue to exist so long as the public continue to foster it by injudicious investment.

The general effect of the Companies' Act of 1900 has been well stated by Messrs. Hurrell & Hyde, who have issued a new edition of their excellent "Joint Stock Companies' Practical Guide":—

"The chiefly against which it is directed are:—(*a*) The 'guinea pig' director, whose qualifying shares have been given him by the promoter; (*b*) the bloated purchase price, loaded with promoter's profits, preliminary expenses, discounts, and commissions; (*d*) the failure of weak underwriters to take up their allotments; and as regards creditors (*e*) the existence of mortgages and charges over the company's property of which investors, with regard to which creditors had practically no means of obtaining information."

The following epitome of the leading features of this important statute may be of value to the reader. In treating of a complicated piece of legislation it is difficult to be clear without being verbose; and in this instance it is often impossible to express the effect of a section without setting out its every word. An endeavour has been made, however, to place before the reader such an epitome of the Act as is consistent with clearness and accuracy.

The Act applies in part to companies which will have been incorporated prior to January 1st, 1901; the remaining provisions of the Act are only applicable to companies incoporated after that date. The most prominent features of the Act which relate to what we may term existing companies include those dealing with—(1) The certificate of incorporation; (2) directors' qualifications; (3) application for shares; (4) allotment of shares offered to the public; (5) return as to allotments of shares; (6) shares paid up otherwise than in cash; (7) underwriting and brokerage; (8) filing of prospectus; (9) contents of prospectus; (10) first general meeting; (11) meetings generally; (12) registration of mortgages; (13) annual list and summary; (14) register of directors and managers; (15) appointment of auditors; (16) rights and duties of auditors; (17) winding up; (18) defunct companies; (19) false statements; (20) conversion of stock into shares.

The provisions which *do not* affect companies incorporated before January 1st are as follows:—Those which relate to—(1) The declaration on incorporation; (2) the appointment and advertisement of directors; (3) restrictions on commencement of business; (4) variation of contracts referred to in the prospectus; (5) statutory meetings; (6) companies limited by guarantee.

The Act also varies slightly in its application to different classes of companies; and it emphasises a distinction between public and private companies. It is impossible, within a limited space, to draw attention to all these distinctions, but a private company is always hereinafter distinguished from one to which the public have been invited to subscribe.

Incorporation and Objects.

The first section of the new Act provides that the certificate of incorporation of any company, whether given before or after the passing of the Act, is to be conclusive evidence that all the requisitions of the Companies' Acts in respect of registration have been complied with. In deciding whether he shall or shall not grant the certificate, the Registrar may rely upon the statutory declaration of the solicitor, or any officer of the company. In any event, such a statutory declaration must be made. That caution will have to be exercised by those who make the declaration becomes apparent, when we consider the penalties which can be inflicted for making a false statutory declaration.

Directors.

The expression "director" includes any person occupying the position of director, by whatever name called [Section 30]. By Section 2 of the Act it is provided (to put the section in a shortened form) that a person shall not be capable of being appointed a director by the articles, nor shall he be named as a director in any prospectus issued by the company unless before registration of the articles, or the publication of the prospectus he has—

1. Signed and filed with the Registrar a consent to act as director;

2. Either signed the memorandum of association for a number of shares not less than his qualification (if any), or signed and filed with the Registrar a contract to take and pay for his qualification shares, if any.

A list of the persons who have consented to be directors must be delivered to the Registrar by anyone who applies for registration of the memorandum and articles of association. If such list contains the name of any person who has not consented to act, a fine not exceeding £50 may be inflicted on the applicant. It is all important to notice that this section does not apply (*a*) to a private company, *i.e.*, a company which issues no application to the public to subscribe for its shares, nor (*b*) to a prospectus issued by a company after a year from the date upon which the company is entitled to commence business.

Like previous Companies' Acts, the statute of 1900 omits to provide that a director must have *some* share qualification. Where, however, a share qualification is made necessary by the regulations of the company, this Act provides [Section 3 (1)] that a director must obtain his qualification within two months after his appointment, or such shorter time as may be fixed by the regulations of the company. Otherwise he vacates his office; and he also vacates his office if he gets rid of his qualification. A fine of £5 daily may be imposed upon any unqualified person who acts as a director.

The foregoing provisions relating to the office of director will materially assist anyone who is anxious to know who is or who is not a "director." Apparently no one who has failed to comply with the provisions of Section 2 *supra*, can be a director of any public company formed after January 1st, 1901.

II.

New Regulations as to Allotment.

The old regulations still hold good, namely, those which provide that allotment in order to be valid must be made at a duly convened and constituted meeting of the board in accordance with the articles of the company; and in the case of a private company (which we have already described), the new Act makes no further restrictions. It is different, however, with a public company. By Section 4 of the Act of 1900, it is provided in effect that no allotment shall be made unless (*a*) the amount (if any) fixed by the memorandum or articles of association, and named in the prospectus (if any) as the minimum subscription upon which the directors may proceed to allotment; or (*b*) if no amount is so fixed and named, then the whole amount of the share capital has been subscribed, and the sum (if any) payable on application has been paid to and received by the company. The amount so fixed and named, and the whole amount aforesaid, are to be reckoned exclusive of any amount payable otherwise than in cash, *e.g.*, exclusive of money paid in shares to vendors to the company, and by Sub-section 3 it is provided that the amount payable on application shall not be less than 5 per cent. of the nominal amount of each share. Unless these conditions are complied with on the expiration of 40 days after the first issue of the prospectus,

all money received from applicants for shares shall be forthwith repaid to the applicants without interest, and any condition requiring any applicant for shares to waive compliance with any requirement of this section shall be void.

Perhaps the most important feature of this section is that which prohibits directors from waiving the obligations which are imposed on them by statute. [See also Section 10, Sub-section (5) *post.*] The section has no application to any allotment of shares made subsequent to the first allotment of shares offered to the public, save that the amount payable on application can never be less than 5 *per cent.* of the nominal amount of each share.

When this important section comes into force, it can hardly fail to put a stop to allotment on insufficient capital, for as we have seen, unless there is some provision in the articles providing for allotment on payment up of a certain proportion of each share applied for, directors must wait for payment in full, although, of course, it will be open to directors to fix a nominal amount in the articles. Moreover, it is provided by Section 5 that any allotment made in contravention of this section is voidable at the instance of an applicant at any time not later than one month after the statutory meeting, although the company may be in liquidation; and directors who knowingly contravene the section are liable to compensate the company and any other for loss sustained thereby.

Return of Allotments.

It is provided by Section 7 that within one month after allotment, a company must file with the Registrar a return stating (*inter alia*) (*a*) the number and nominal amount of the shares comprised in the allotment as well as the names of all others; (*b*) a contract in writing showing the title of any allottee who has paid any consideration other than cash, together with any contract for sale, or for services or other consideration in respect of which such allotment was made, such contracts being duly stamped. A return must also be filed stating the number and nominal amount of shares so allotted, the extent to which they are to be treated as paid up, and the consideration for which they have been allotted.

Default in complying with the requirements of this section renders every director, manager, secretary, or other officer who is knowingly a party to the default, liable to a fine not exceeding £50 for every day during which the default continues.

Commencement of Business.

Hitherto a company has been at liberty to commence business immediately after incorporation. In future, however, before a public company registered under the Act of 1900 can commence business or exercise powers, a statutory declaration, signed by the secretary or one of the directors, must be registered with the Registrar of Joint Stock Companies stating that the shares held subject to the payment of the whole amount thereof in cash have been allotted to an amount not less in the whole than the minimum subscription, and that every director has paid to the company on his qualification or other shares a sum in cash proportionate to the amount payable on application and allotment on the shares offered for public subscription. It is also provided that if business should be commenced, or borrowing powers be exercised in contravention of these provisions, every person responsible for the contravention shall be liable to a fine not exceeding £50 a day during the period the contravention continues.

The Prospectus.

Before referring to the drastic changes which the new Act has made in the essential requirements of a prospectus, it is important to observe that there is still no need for any company to issue a prospectus. Sections 9 and 10 of the Act of 1900 have made so many important changes, that some writers, and notably Messrs. Hurrell & Hyde, the learned authors of "The Joint Stock Companies' Practical Guide," are of opinion that "no-prospectus" companies will increase in number when the new Act comes into force. The expression "prospectus" means any prospectus, notice, circular, advertisement, or other invitation offering to the public for subscription or purchase any shares or debentures of a company [Section 30]. The following are the requirements of the future prospectus:—

1. It must be dated (Section 9 (1)).

2. A copy must be signed by each director, and filed with the Registrar (Section 9 (3)).

Section 10 deals with the contents of the prospectus. It must contain the following particulars (*inter alia*):—

(*a*) The memorandum: and the names and addresses of the signatories.

(*b*) The share qualification and remuneration of directors.

(*c*) The names, descriptions, and addresses of proposed directors.

(*d*) The minimum subscription on which directors may proceed to allotment.

(*e*) The number and amount of shares, &c., issued, or agreed to be issued, as fully or partly paid up otherwise than in cash.

(*f*) The names and addresses of the vendors, whether actual or original, of any property to the company who receive any of the proceeds of the issue, including lessors to the company.

(*g*) The amount payable in respect of property purchased, as mentioned in Paragraph (*f*) *supra*, together with a statement showing how much was paid for goodwill.

(*h*) The amount of commission paid to underwriters.

(*i*) The amount, or estimated amount, of preliminary expenses.

(*j*) The amount paid, or intended to be paid, to any promoter, and the consideration for any such payment.

(*k*) The dates of, names of parties to, and place for inspection of, every material contract made within three years of incorporation, other than contracts entered into in the ordinary course of business of the company.

(*l*) The names and addresses of the auditors (if any).

(*m*) Particulars disclosing the interest of every director and promoter in the property acquired by the company, including a statement of the amount of his qualification shares.

The foregoing provisions (which are taken from Section 10, Sub-section 1) as applicable to a prospectus, are subject to the following reservations. The section does not apply to a circular or notice inviting existing members or debenture-holders to subscribe for further shares or debentures (Sub-section 4), and when the prospectus is published more than one year after the date at which the company is entitled to commence business, the matters dealt with under the headings (*a*), (*b*), (*c*), (*i*) and (*m*) need not be disclosed; while the obligation to disclose material contracts is in that case limited to two years immediately preceding the publication of the prospectus. The obligations imposed upon them by this all-important section cannot be waived by directors. In order to save the expense which would attend the publication of such a lengthy document, it is provided that the "memorandum" need not be published in any newspaper advertisement of the prospectus.

When drawn in the proper form, the new prospectus will make subscribers acquainted with all material facts connected with the flotation of a company. The real vendor, the amount of the purchase money, and what amount of purchase money the vendor is to receive, must all be disclosed.

It is a remarkable fact that the Act does not state what the legal consequence will be if a promoter or director omits all or any part of the particulars that must be set out in the prospectus. He incurs no liability, however, if (1) he was not cognisant of non-disclosure; (2) non-compliance arose through an honest mistake of fact. It is provided, however, that nothing in the section shall limit or diminish any liability which any person may incur under the general law, apart from the section.

When this section was under discussion in committee, it was moved by Mr. McArthur that its application should be limited to public companies, but this proposal was rejected. Every prospectus, even of a one-man private company, must in future be filed, but, of course, as we have already mentioned, the propectus itself is not essential. It was suggested that private companies having no prospectus should be compelled to publish and file a memorandum conforming to the requirements of the clause, but Mr. Ritchie pointed out that this would have the effect of compelling every company to publish a prospectus, which would act as a deterrent to

enterprises of this kind. Nevertheless the directors of a company who do issue a prospectus and omit to file the same are liable for a misdemeanour at common law.

(To be concluded.)

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Musical Arcs, Induction Coils, and High Tension Switches.

Mr. Duddell's paper on "Rapid Variations in the Current through the Direct Current Arc" on Thursday evening last week was a relief to many of the members after the highly controversial matters which have recently occupied attention. The theatre of the Institution of Civil Engineers presented the appearance of the Royal Institution on an electrical night, and this feeling was justified by the excellent manner in which the demonstration was conducted. To hear a popular and patriotic air played upon an arc or by an arc was so novel a thing that many who would otherwise despise high science will be tempted to carefully study the paper to know "how it was done." Not less interesting is the bearing of Mr. Duddell's experiments upon the action of fly-off switches on, say, high tension circuits. Lastly, the meeting was spared a lengthy discussion, and members were permitted to retire to debate the things they had seen while the coffee was hot downstairs and the brain was fresh. Of the other good things provided and demonstrated in quite the Royal Institution fashion, was the way in which the output of a spark coil could be increased by opening the primary circuit *before* connecting the condenser across the gap so formed. We want a few more papers like Mr. Duddell's, and it is to be hoped that among the Associates of the Institution are to be found enthusiastic and able young experimenters who will show as clearly as he has done how very practical abstract research investigations can be made, and to what a very real extent the results of such work may modify, or at least throw light upon, the severely utilitarian work of the designer and erector.

Prof. Ayrton voiced the exquisite pleasure with which the paper had been listened to—not that he had any claim upon it, but was as pleased as if he had been the writer. He was convinced that these experiments of the evening would assist in the development of the morrow, and it rejoiced the life of a professional man, in this age of professors, to find a student alert to catch at and magnify any hints he received from nature or from man. Much would be learned from Mr. Duddell's work of two years ago and of that evening. It demonstrated how valuable was the investigation of Messrs. Frith and Rodgers, which had brought out an absolutely new fact. Given one circuit containing an alternator, dynamometer, and inductance, and another circuit of a battery, resistance, and arc, it was shown that if you made a break in the former circuit and connected the arc therein, the current in the alternating circuit was increased. When it was stated that with solid carbons the ratio of the instantaneous P.D. change to the instantaneous current change gave a negative value, there was a howl of indignant criticism. In the Middle Ages anyone who had stated such a thing so opposed to current opinion would undoubtedly have been burnt, but the conventional antagonism was modified by finding men like Prof. Gray, then of Bangor, and now Lord Kelvin's successor, Mr. Oliver Heaviside, and Prof. Fitzgerald on the other side. Mr. Duddell had cut the cake open to see if there were any plums inside. The real significance of all this work should be emphasised as it bore upon Dr. John Hopkinson's proof that two alternators could not be run in series. Years ago Dr. Sumpner had shown that under some conditions the true power taken by a solid carbon arc was less than the apparent power with alternating currents, and the speaker was convinced that under certain circumstances a direct current arc behaved in a similar manner. An arc properly treated was the most sympathetic soul one could ever meet.

Dr. Fleming found it very difficult to decide upon what to most congratulate the author who had given this perfectly delightful paper. It was a splendid piece of scientific work. He explained how the addition of the condenser to the arc might cause the arc to be extinguished and again relighted by the discharge of the condenser, but the metallic arc was not relighted, owing, it might be said, to the vapour vanishing too quickly. This series of experiments might cause heart-searching amongst those who had been responsible for the design of high-tension switches. A switch had been submitted to him in which the break was designed to take place between non-arcing metals, but it seemed, in the light of these investigations, that this was going the wrong way, and that as the arc could be regarded as being under perfect control it should be allowed to start and then whittled down until extinguished. An induction coil, which worked perfectly well with a small number of cells, when put on a 100-volt circuit with a resistance would hardly give any results, and the explanation seemed to be that with the higher volts the arc is drawn out at the contacts. The moral taught was that one must do exactly the opposite of what is done with high tension switches. Those who designed such apparatus might well "consider their ways and be wise."

PRACTICAL CONSIDERATIONS INVOLVED IN THE GENERATION OF POWER BY BLAST FURNACE GAS.

(Continued from page 580.)

Before continuing this article, we wish to draw attention to a slip on page 580. The volume of gas available for utilisation for the development of power was there given as 193,602 cubic feet, instead of subtracting that as the amount required to supply the heat of the air blast, including 20 per cent. unavoidable loss, from the total volume of gas evolved per hour from each furnace.

This should read as follows:—

Total volume of gas evolved per hour		455,260 cubic feet
To supply the heat of the air blast (rather less than a quarter of the total volume)	102,550	
If we allow 20 per cent. of total to cover unavoidable waste... ...	91,052	
		193,602 „
Available for utilisation in development of power		261,658 „
261,658 cubic feet of gas per hour at 100 B.Th.U. = 26,165,800 B.Th.U. 1 H.P.-hour is equivalent to $\frac{33{,}000 \times 60}{778}$ ... ... =		2,545 B.Th.U.
Therefore, the above quantity of gas is theoretically capable of developing		10,280 H.P.
The gas engine is capable of turning 28 per cent. of the heat into available power, giving		2,878 H.P.

A correspondent, Mr. Ivon M. de Havilland, has suggested that the heat of the air blast should be derived from the exhaust gases from the gas engine in place of burning the gas in stoves, thus increasing the efficiency of the system; this may be stated as follows, in preference to the figures he gave:—

	B.Th.U.
Heat converted into work by the engine, 28 % ...	10,197,824
„ absorbed by water jacket, 40 %	14,568,320
„ utilised in heating the blast, 17·5%	6,365,406
„ of exhaust not recovered, 14·5 %	5,289,250
	36,420,800

The useful efficiency of the system being therefore 45·5 %.

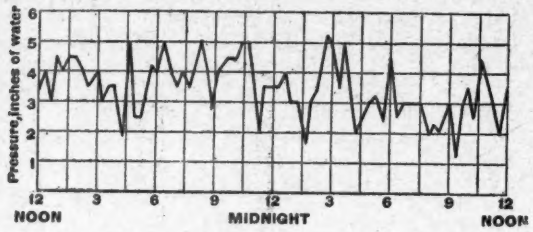
We may point out in this connection that there is a possibility of saving a considerable proportion of the jacket water heat where boilers are still retained in the blast furnace plant, for if the jacket water is employed as feed water for the boilers the 40 per cent. of heat which is carried away through this path can largely be recovered.

The Thwaite-Gardner system includes a scheme for

using the sensible heat of the waste gases for heating the air blast in a manner somewhat similar to that proposed by our correspondent.

Blast furnace gas is generally considered to be somewhat inferior to producer gas from the point of view of its combustible qualities, but when due consideration is given to the slight variation in its content of combustible gases, it will be found that the average composition is so much more constant than in the case of producer gas, that it is far in advance of the latter as a fuel for gas engine purposes.

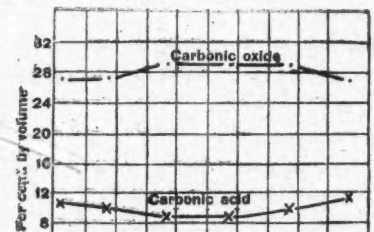
The diagram given in fig. 1 shows the variations in chemical composition per cent. by volume of the gases evolved by a range of 13 blast furnaces; the small



Variation in pressure of gas in main flue from a range of 10 furnaces, fitted with cup and cone, closed top, during 24 hours.

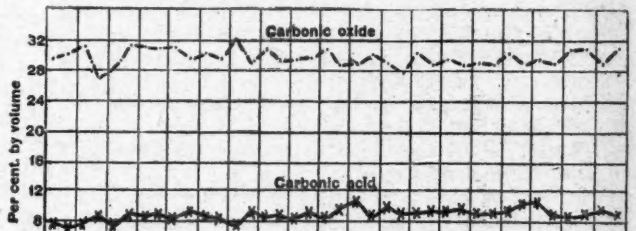
Fig. 3.

difference in composition is the more remarkable from the facts that one of the furnaces was producing Spiegeleisen, requiring 28 cwt. of coke per ton of metal produced, while the others were making Bessemer pig and used only about 20 cwt., and that the temperature of the air blast varied from 870° F. to 1,320° F. at the different furnaces at the time the samples of gas were taken for analysis. Diagram fig. 2 shows the composition of the gas from a single furnace, the samples of gas being taken on six out of seven consecutive days.



Six analyses of gas from one furnace; coke fuel; Spanis and French ore; limestone flux.

Fig. 2.



88 analyses of gas from 13 furnaces made on 88 out of 60 days. Coke fuel; haematite ore; limestone flux.

Fig. 1.

The arrangements for the utilisation of blast furnace gas existing before the introduction of the gas engine may now be reviewed.

Leaving out of consideration those blast furnaces which allow the whole of the evolved gases to pass into the atmosphere, thus directly wasting over 60 per cent. of the heat value of the fuel, as these furnaces at the present time constitute only a very small proportion of those in blast, we may take it that in general some system of utilising the gases is adopted.

A by no means uncommon method in this country is to draw off the gas from a point some little distance below the top of the charge in the furnace, by means of chimney draught; in this case some of the gas escapes and becomes ignited at the mouth of the furnace, the only benefit being the drying of the materials of the charge and the driving off of any combined water contained in the ore employed. This method must be a very inefficient one, as the gas cannot become ignited until it obtains its necessary supply of oxygen, and this only occurs at the surface of the fuel and ore, the greater portion of the heat thus generated passing directly into the atmosphere.

This system is also associated with the difficulty of properly regulating the proportions of air and gas necessary for efficient combustion, owing to the fact that the admission of air at any point in the system has the effect of reducing the draught in the tubes through which the gas passes, due to the limited dimensions of the chimney. Under this system the gas flues and tubes are all under suction, and wherever leakage is possible air enters and mixes with the gas, so that only a comparatively small draught can be maintained.

The more perfect arrangement for the recovery of the gases is the cup and cone, or bell and hopper method.

The top of the furnace is in this case perfectly closed by a valve which is only opened to admit the materials constituting the charge at frequent short intervals, and with the exception of that which escapes during the time the cone or bell is lowered, the gas is directed into flues and rendered available for utilisation.

The loss of gas due to the furnace top being for short intervals open to the atmosphere has been already referred to, as well as the improved method of reducing even this small proportion of loss.

The difficulties to be overcome in the burning of the gas under this system include—

1. The variation, from time to time, of the sensible heat of the gas. The temperature of the gas from an 80 feet furnace varied from 250° F. to 1,027° F.*

2. The difference in the pressure under which the gas is delivered to the boiler furnace, through the lowering of the bell for charging the furnace, and the necessary reduction of the blast pressure at casting time, &c.

Diagram fig. 3, showing the pressure of the gas in the main flue from a range of furnaces, illustrates these changes very clearly.

To regulate the proportion of air for the efficient burning of the gas under these conditions will be seen to be a matter requiring constant attention.

The determination of the volume of gas required to be burned in the furnace of a boiler to develop 1 H.P.-hour is almost impossible, with any degree of accuracy, but estimations have been attempted, resulting in the following figures being adopted for comparison.

M. Adolphe Greiner, in his paper read before the Iron and Steel Institute, May, 1898, gives the following particulars:—

At Seraing, the average output amounts to 600 tons of pig-iron daily. It is generally agreed by Messrs. Hubert Lurmanns, and others, who quote the calculations of Mr. Hiertz, that the average gas production amounts to 4,500 cubic metres (158,924 cubic feet) of gas per ton of iron.

At least 2,000 cubic metres (70,633 cubic feet) is used under the boilers, and the remainder is accounted for by the stoves and by leakage. Six hundred tons daily correspond to 25 tons hourly or 50,000 cubic metres (1,765,830 cubic feet), of gas used hourly for raising steam.

The boilers actually at work have a heating surface of 2,300 square metres (24,757 square feet), out of a total of 2,750 square metres (29,601 square feet), a goodly number of the boilers being always laid up for cleaning. The blowing engines, lifts, pumps, &c., together average 2,300 I.H.P. Careful experiments show that 12 to 15 kilogs. of water are evaporated per square metre of heating surface (3·45 to 3·07 lbs. per square foot) per hour, and this is about the same as is obtained in other works using Cornish boilers. The total 2,300 square metres (24,757 square feet) give 28,000 kilogs. (61,729 lbs.) of steam per hour at a pressure of four to five atmospheres or about 12 kilogs. (25·45 lbs.) of steam per I.H.P.-hour, when all the machinery and losses by condensation are taken into account. This figure

* Sir I. Lowthian Bell.

has been confirmed at Seraing by direct tests of the consumption of different machines.

The following results are thus shown in current practice:—

$\frac{50,000}{28,000}$ = 1·8 cubic metre of gas per kilog. of steam,

= 28·9 cubic feet per pound of steam.

$\frac{50,000}{2,300}$ = cubic metres of gas per horse-power-hour,*

= 776·96 cubic feet of gas per horse-power-hour.

There are some modern plants where better results are attained, but even then they might be dubbed laboratory experiments. Pumps, lifts, and other appliances, which make excessive demands on the steam supply, are left out of consideration; and, besides, the boilers are carefully cleaned and tended in readiness for the test, so that exaggerated returns are made. The totals given above are, on the contrary, the results of every day work, on which all calculations ought to be based.

In Bauerman's "Metallurgy of Iron," page 267, we read: "If now the consumption of coke be 30 tons per day, the gases if applied to steam boilers will by their combustion raise steam for an engine of 257 H.P." We have stated above that each ton of coke consumed in the blast furnace gives 170,000 cubic feet of gas; therefore the quantity of gas per hour = $\frac{170,000 \times 30}{24}$ = 212,500 cubic feet; $\frac{212,500}{257}$ = 826 cubic feet per horse-power-hour.

The analysis of the gas is as follows:—

PERCENTAGE BY VOLUME (BAUERMAN).

Carbonic acid	CO_2	9·21
„ oxide	CO	26·60
Hydrogen	H	1·00
Marsh gas	CH_4	...
Nitrogen	N	63·19
		100·00

Thermal value per cubic foot, at 60° F., 87·67 B.Th.U.

M. Enrique Disdier, in a paper read before the Iron and Steel Institute, May, 1899, on "The use of Blast Furnace and Coke Oven Gases," gives the following figures:—

"In well arranged steam generators connected with by-product ovens using coal containing 27 to 30 per cent. of volatile matter, each pound of coal charged will evaporate 1 lb. of water under a pressure of five atmospheres;" he assumes that 26·4 lbs. of water thus evaporated will develop 1 H.P.-hour.

1 lb. of coal gives off about 4·47 cubic feet of gas, and 4·47 × 26·4 = 118 cubic feet of gas to develop 1 H.P.-hour.

The gas in question having a thermal value of 540 B.Th.U. per cubic foot would require, as its equivalent of blast furnace gas of 100 B.Th.U. thermal value, over 600 cubic feet to give 1 H.P.-hour.

Herr Neumann, of Köln-Deutz, in a paper on the "Propulsion of Gas Engines by means of Blast Furnace Gases, with special Reference to the Manufacture of Calcium Carbide," says "When burnt under a boiler, 350 to 400 cubic feet of carbon monoxide were required to yield 1 H.P.-hour, but in a gas engine 100 feet to 120 feet sufficed."

Prof. Aimé Witz, in a paper read at the International Gas Congress at Paris, gives the following proportions between the power developed by blast furnace gas under steam boilers and in gas engines:—"According to the original statement of a famous inventor, smelting is really a secondary operation of the blast furnace, which may be regarded as a gigantic gas producer, yielding 150 tons of pig iron on the one hand, and 600,000 cubic metres (21,186,000 cubic feet) on the other. Reckoning half this gas for heating the blast and for other purposes, there remains a surplus of gas from a blast furnace of 150 tons, sufficient to produce 3,500 H.P. in gas motors; 1,000 H.P., and sometimes not so much, is obtained with difficulty when the gases are used to raise steam."* The ratio in this case between the gas engine and steam boiler is 3·5 to 1.

The results given above may be summarised as follows:—

To develop 1 H.P.-hour by means of burning the gas in steam boilers:—

Greiner	777 cubic feet of gas	at about 100 B.Th.U.
Bauerman ...	826 „	at 87·7 B.Th.U.
Disdier	600 „	at 100·0 B.Th.U.

Expressed in B.Th.U. per H.P.-hour:—

Greiner	77,700 B.Th.U.
Bauerman	72,440 „
Disdier	60,000 „

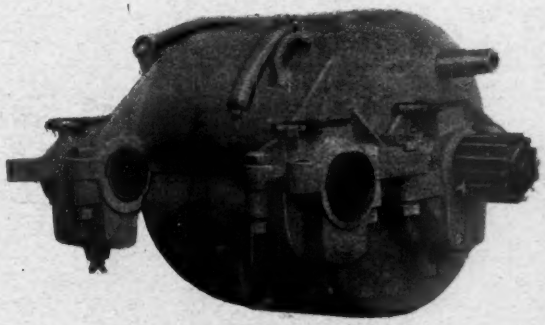
And when all the surrounding circumstances are taken into account it may be considered that these estimates are very close to fact.

(To be continued.)

ELECTRICAL TRAMWAY EQUIPMENTS.

THE Brush Electrical Engineering Company have been the pioneers of British-made traction equipments, and credit is due to them for the successful manufacture of a line of standard apparatus competing in cost and excellence with the foreign-made equipments, which were first in the field, and were backed by the prestige of a lengthened experience. The company can now point to equipments of their own manufacture in which all initial difficulties have been surmounted, and can confidently affirm that to-day their traction apparatus holds a position second to none in every essential that makes for success.

We illustrate their standard motor for lines of 3-foot



1,000A TRACTION MOTOR.

6-inch gauge, known as the 1,000 type, and made with four different windings, to give 17 H.P., 25 H.P., 30 H.P. and 35 H.P. at their standard rating.

The lowest rated motor is specially suitable for tramways without heavy gradients and with single-deck cars, where a high speed is not required. It has a very high "force factor," enabling a start to be made with a very small current. The

* Theory indicates a cubic metre of gas for 1 kilog. of steam generated, as is shown by the following calculations. The calorific value of a cubic metre of blast-furnace gas at 15° C. and 760 mm. pressure with 1 per cent. of moisture is 1,000 calories, as stated above. Good boilers should utilise 65 to 67 per cent. of this amount, but at the blast-furnace plants the dusty flues prohibit such good returns as a rule. The combustion of a cubic metre of gas will therefore not give more than 670 calories. For the sake of comparison with gas engines, assume a steam engine working at 15 atmos. pressure. The total heat contained in 1 kg. of steam at this pressure (corresponding to 200° C.) is—

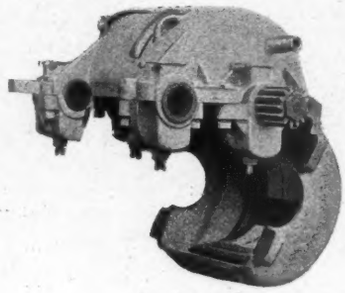
606·5 + 0·305 × 200 = 667·5 calories.

A cubic metre of gas burnt under the boilers can then evaporate as a maximum $\frac{670}{667·5}$ = 1·003 kilog. of water. Thus in round figures a cubic metre of gas will generate a kilog. of steam. The evaporation may be increased by saving some of the heat escaping in the chimney by using feed-water heaters or economisers; but at most the yield would not be increased beyond 80 per cent., thus giving 1·2 kilog. of steam per cubic metre of gas. Under ordinary circumstances, a kilog. of steam at the boilers does not mean a kilog. of dry steam at the engines, owing to loss by condensation in the more or less extended ranges of steam-pipes. Therefore it is safe to repeat, without discounting future advance too heavily, that no more than 1 kilog. of steam is to be expected from a cubic metre of blast furnace gas, or about 0·062 lb. of steam per cubic foot.

* *Electrician*, October 12th, 1900.

35-H.P. motor of this type has been made simply to satisfy the demand which is frequently found in specifications, for a 35 H.P. to fit a 3-foot 6-inch gauge. The limitations of space available on a 3-foot 6-inch gauge are such as to make it inevitable that a motor to develop 35 H.P. must do so at a high speed. This means a low force factor and a very large increase of starting current. Apparently the only solution of an efficient equipment for narrow-gauge lines requiring a high speed on a gradient is the adoption of bogie trucks with four motor equipments. The 25-H.P. motor of this class is a serviceable compromise between these extremes, and fills all the requirements as to speed and tractive effort for an average line. We give its characteristic curve, which bears out our foregoing remarks.

Armature down.



Armature up.

1,000A Traction Motor.

The rating of traction motors is a matter which is seemingly unimportant, but which, nevertheless, influences the purchaser, and the use to which the apparatus is put. The standard American rating is based on one hour's run at rated load with a temperature rise of 135° F. It is quite clear that this rating is empirical, and is not intended to represent actual working conditions. The Brush Company's rating is based on a rise of 115° F. after one hour's run at rated load, and they claim that this represents more nearly the capacity of the motor to do its work without injurious heating.

Besides the 1,000 type, the Brush Company are also offering a type of motor known as the 1,200A type, which is suitable for tramways of standard gauge. This motor is rated at 35 H.P. at a low speed, and can handle the heaviest kind of holiday traffic on steep gradients without any danger of overheating.

The question of overheating is, in fact, the crux of the traction motor problem. The motors may exert on test, and show on their characteristic curves, the necessary combination of speed and torque, but the proof of a good motor is its capacity to work at a temperature that does not quickly bring it into the repairing shops. It is true that performances are sometimes demanded which are outside the possibilities of the dimensions available, but on the other hand, the influence of good ventilation will often go a long way.

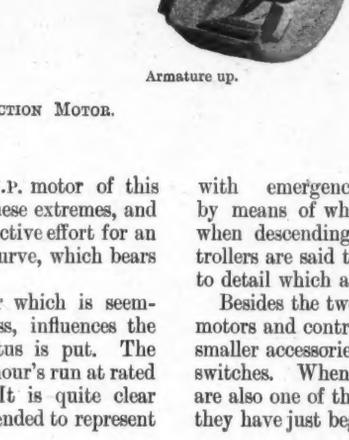
The ventilating arrangements in the Brush motors are very efficient indeed. The upper pole-pieces are slotted out from their face to the outside of the frame, and the openings are protected by a shield and a raised edge. The armature has a ventilating slot from the shaft to the periphery and air ducts parallel to the shaft supply air at a low speed, which is thrown out at the periphery, and blown through the pole-faces to the outside. This ventilation (which is, we believe, the only positive ventilation yet fitted to a traction motor) is extremely effective, and has enabled the Brush motors to be rated 20° F. below most of the motors of similar capacity on the market.

The frame is made to open downward and the armature, by a very simple arrangement shown in our illustrations, can be lowered with the bottom half, or left suspended in the top half as may be convenient.

Another feature of the motors is the application of automatic oil ring lubrication to the axle bearings. This improvement is of the utmost importance in keeping down the cost of repairs and renewals. The life of the bearings is increased from three to four times that which is usual with grease lubrication, and the effect on the wear of the gear wheels is almost equally marked. The reason for this is often overlooked, which is, that any wear in the motor axle bearings leads to a displacement of the gear pitch circles and a corresponding increase of wear and low efficiency. It is, therefore, true economy to give as much attention to the axle as to the armature bearings, and without oil lubrication this is not easy to do.

The Brush Company manufacture several types of controller, among them being the H1 single motor controller, H2 series parallel emergency brake type, HD2 series parallel controller with rheostatic brake, and the HG2 series parallel controller with emergency stop, and a regenerative position by means of which the car may return energy to the line when descending long and steep inclines. All these controllers are said to be made with an accuracy and attention to detail which are quite uncommon.

Besides the two chief items of traction equipments, viz., motors and controllers, the Brush Company manufacture the smaller accessories, such as rheostats, fuse boxes and canopy switches. When in addition to this we remember that they are also one of the largest builders of car bodies, and that they have just begun to place a whole line of standard trucks on the market, it must be admitted that they are in a most advantageous position to supply the growing demand for electrical traction apparatus.



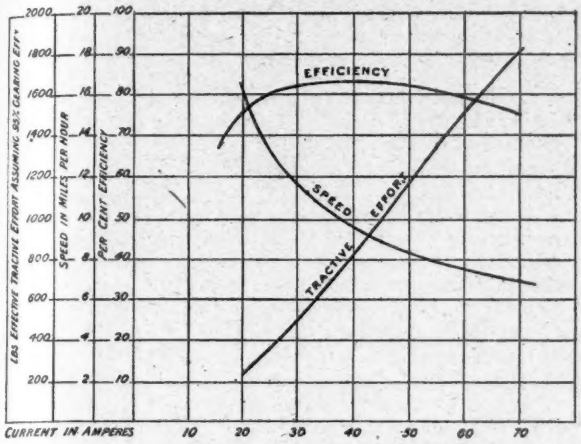
H2 Controller.

HD2 Controller.

PROF. PERRY'S ADMONITION.

During the month that has elapsed since the publication of Prof. Perry's inaugural address as President of the Institution of Electrical Engineers, a great number of comments and criticisms have appeared with reference to that stirring

speech ; proving that the topic is of far reaching interest. His immediate subject was "Electrical Engineering as a Trade and as a Science," but it is generally recognised that his admonition is applicable to all professional men properly so called. It is obviously intended to urge British engineers to keep their mental mechanism in order, to stimu-



Characteristic curves of 1,000A traction motor. 500 volts. Gear ratio 4·78. Wheels 30 inches diameter. Axle speed (revolutions per minute) = miles per hour × 11·25. Armature speed (revolutions per minute) = miles per hour × 53·75.

Electrical Tramway Equipments.

late them to a sense of pride in their splendid calling, and at the same time it seeks to advise them to keep in competitive touch with the men to right and left of them. Their fighting weapon is to be mathematics, sharpened by contact with affairs, and polished by disciplined imagination. If they succeed, engineering is to remain a profession. If they fail, it is to sink into a trade. If they win, engineering institutions are to continue to be societies for the advancement of knowledge in the applications of scientific principles to industrial needs. If they lose, such institutions are to degenerate into mere trades' unions.

Some of Prof. Perry's critics have expressed surprise at his lack of definitions, and his indiscriminate use of terms. He has no mercy on the "old mathematics," whatever that may mean, but he thinks all things of the "new mathematics," though he does not deem it worth while to explain to his hearers wherein the distinction lies. No doubt this is the worst feature of the discourse, but his critics should remember his nationality, and that he is fighting, and that he is fighting against an injustice. It is obvious enough that he is declaiming against the fantastic illusions that pass as mathematics in those preparatory schools for young gentlemen, where Euclid and Ptolemy stalk ghost-like through the corridors, doomed to all time to frighten youngsters into the stupidity that mathematics is unreal. Whereas, Prof. Perry would have them taught that mathematics is the most tangible thing in the universe, because it is the truest. He would have it brought home to them that every process in a mathematical development corresponds to a physical operation, that mathematics is but nature's quiet method of knitting for her children, and he would insist that all her children should learn to knit.

His next point is the importance of developing the imagination. No doubt here was another reason why he omitted a few definitions. He sees that mathematics cannot of itself people the universe, it can develop manhood, but it cannot make a gentleman. It is said that Prof. Perry has so clearly realised the importance of the study and assimilation of imaginative literature, that he gives his own students the option of perusing a novel, in place of answering a certain number of the questions set by him at examinations. The improvement in general knowledge among his students is thereby most strikingly developed, and it is observed that quite a number of them now read French with facility. It is in this appreciation of the more inventive, kindlier, more human aspect of humanity that we recognise the truth and force of the President's address. As we read such sentences as the following, we ask ourselves are we here breakfasting with the professor, the poet, or the autocrat : "A strong imagination well under control, surely it is the greatest of mental gifts. I look around me and wonder how many of us really have it ; and how many of us are only dull music hall-loving men, who scorn novels and poetry, who live utilitarian, material lives—whose aim is merely to make money."

Here, again, comments have been raised on the view which Prof. Perry appears to hold with regard to music halls. The President, it would seem, is somewhat averse to them, and yet we doubt whether he would object to any of the younger members whose interest haply turns from a discussion on boosters to the study of the flora and fauna, getting up just for once from the quiet seats of the Institution to note the gyrations of a *Palæaster asperimus* at the local piscatorial establishment. For at no place in the world is it desirable to remain through a heated and disinteresting discussion. Truly it is not far from Great George Street to Tothill Street. So near is the sublime to the ridiculous. By just so much should mathematical wisdom be removed from imaginative instinct. That is the secret of genius.

There is a good deal of useful advice offered by the President to individuals and to the profession of engineering. As regards the individual, he shows how easy is the descent from South Kensington. "The man who loses the power to calculate, who loses his grip of the simple theory underlying his work, must sink." He is applying the principle of the survival of the fittest, while around him he sees the evidences of the increasing struggle for existence—the ever-growing complexity of machine-design, and the ever-present alertness of the "clever foreigner." This must be combatted by superior knowledge, which again is only to be attained by revision of our methods of teaching, and by determination on the part of individuals to keep themselves to gauge. The critics complain that there is no time for such self-improvement. There is much truth in what they say, and some romance. Darwin expressed his appreciation of this difficulty as well as it can be put, and the way out of it, in his lofty words : "I have worked as hard and as well as I could, and no man can do more than this." We shall not fail for lack of this valiant example.

The groundwork of the address is a consideration of the question of decadence, and here there is no want of definition. "A *profession* implies the necessity for the exercise of all one's past experience" ; a *trade* differs from this because to a tradesman "the work is cut and dried." We remember once asking the late Dr. Martin Duncan to direct us as to the best authorities on the Palaeozoic and Neozoic corals. His reply was that the subject was "treated of" in his own book on the subject, and "dealt with" in a certain part of a well-known compendium of science. That seems to us the true distinction between a professional man and a tradesman. The one treats of a subject, the other deals with it. Treating of a subject should imply originality of thought and the introduction, so to speak, of new blood into the old stock. Dealing with a subject is an anæmic reduplicating process, generally indulged in for some sordid gain. The progeny may be great, but is often weak, as when cousins marry.

Prof. Perry comes to us like the friend of the family, and seeks to save the century from this dire calamity by his prescription of mathematics and imagination. We are obliged to ask ourselves : While there are men with such original views of things, can decadence be possible ? With his love for the novel, no doubt he is an admirer of George Sand, who sometimes wrote with a "fond de réalité historique." She pictures for us an old *savant* of two centuries ago, who laments : "Nous vivons dans un siècle de décadence ; les races dégénèrent, l'esprit de conduite se perd dans les familles. Anjourd'hui, pourvu qu'on fasse fortune, on ne regarde pas aux moyens, on ne craint pas de déroger. De noble, on se fait trafiquant ; de maître, manœuvre ; d'architecte, maçon ; de maçon, goujat." The reply to this is : "Il vaut mieux être un bon ouvrier qu'un maître médiocre, un grand artisan qu'un artiste vulgaire."

From Jeremiah to George Sand, from George Sand to Prof. Perry, covers a long period of recorded time ; but the centuries survive our fears. The true tradesman—your business man—is as necessary to the engineering life of England as is the most imaginative mathematician. The Institution at Great George Street does well ; it provides us

with every variation and type, including the mathematical imaginative tradesman. There is hope, therefore, for the new century, in which the developments of science are to do so much for man. Lambkin states it thus in his memorable "Newdigate" poem :—

> Life is a vale, its paths are dark and rough,
> Only because we do not know enough.
> When science has discovered something more,
> We shall be happier than we were before.
>
> R. A.

ELECTRICAL ENGINEERS R.E. VOLUNTEERS.

On Monday evening last the members of the Active Service Contingent of the Electrical Engineers (R.E.) Volunteers were welcomed home at a dinner given at the Prince's Restaurant. To a great extent the hosts who proffered this welcome were the same as those who on March 3rd last entertained the contingent when leaving England for South Africa. A delicate and sumptuous repast having been disposed of, the chairman, Prof. John Perry (the President of the Institution of Electrical Engineers) proposed the usual loyal toasts, after which Sir W. H. Preece proposed that of "The South African Detachment of the Electrical Engineers (R.E.) Volunteers," coupled with the names of Lieut.-Col. R. E. Crompton and Capt. F. L. Lloyd, R.E. Sir William said it seemed but yesterday that the guests went forth in health and strength and all their natural beauty. Since that time they had experienced many joys and sorrows. He alluded to the various uses to which the force had been put, and designated the "Electrical Engineer" as veritably the "handy man." The Electrical Engineer contingent had passed through dangers and had done splendidly. Cheerfulness and a determination to work away had stuck to them throughout the campaign.

Lieut.-Col. Crompton said he had to respond for a responsible body of men. He had had to tell the same story several times over already and had tried not to contradict himself. He had heartfelt pleasure in meeting the hosts of the evening once again, and was glad to be able to say that 94 per cent. of those he took out had come back again in safety, having had a good time in South Africa, with the merry Basuto alongside with his ever merry smell. He referred to the peculiarities and incidents of the line of march, especially to a ride on bicycles with Captain Leaf down a certain valley in which side-slip was much in evidence. The men of his force, he asserted, were the most intelligent of men from the most intelligent of professions.

Captain Lloyd, in a valedictory address, spoke of the duties the contingent was required to perform, and said that they seemed generally to consist of moving heavy weights in a hurry; but whatever the work was, whatever had to be done, was done. In conclusion, he wished the men good luck! and good bye!

Mr. A. Siemens then proposed the toast of "The Electrical Engineers (R.E.) Volunteers," coupled with the name of Major R. S. Erskine. Mr. Siemens made reference to the three systems of recruiting :—(1) The English; (2) that of Hanover, where he was born; and (3) the Prussian system. Having enlarged on the merits and demerits of each, he said he was once dining in the company of the Archbishop of Canterbury who, in speaking of conscription, said: "Would you, Mr. Siemens, take a young man from the bosom of his family?" To which the speaker replied, "That, my lord, would depend upon the bosom."

Major Erskine then gave some very satisfactory figures relating to the corps, with a complimentary reference to the adjutant.

Mr. J. W. Swan, in suitable and sad terms, gave the toast of "To the Memory of the Members of the Corps, who fell in the Service of their Country," reading aloud the names of the four, namely, Sapper E. C. Short; Sapper W. C. Weakley; Second-Corporal A. Holdaway; and Sapper E. J. West, all of whom died of enteric fever.

The toast having been honoured standing and in silence, Mr. Edmunds proposed the health of Prof. Perry, which Capt. Leaf seconded.

Prof. Perry, in replying, in a very happy speech, remarked that last year he was made the president of five shooting clubs, which, *sotto voce*, all involved a subscription from him. He then dilated on the wonderful future of the Electrical Engineers, after which the evening was brought to a close by the singing of "God Save the Queen" and "Auld Lang Syne."

The formal reception of the South African Contingent by the President and Council of the Institution of Electrical Engineers took place on Tuesday evening in the Covent Garden Opera House, kindly lent for the occasion by Mr. Rendle and Mr. Forsyth.

Almost every available seat was occupied in good time, a very large proportion of ladies lending brightness to the gathering. A guard of honour provided by the corps of Electrical Engineers Volunteers, under the command of Major R. S. Erskine, was drawn up round the area reserved for the reception, and the string band of the Royal Engineers performed an excellent programme to while away the time of waiting. At 8.45 the President and Council took up their position on and around the daïs, accompanied by members of the Institution and others holding commissions in the regular or auxiliary forces. The President was supported by Major-Gen. Salmond, R.E. The South African Detachment then marched in, under the command of Lieut.-Col. R. E. Crompton and Capt. F. L. Lloyd, R.E. At their entrance a roar of applause burst forth, while the band played "See the Conquering Hero Comes," and the guard of honour presented arms. The detachment was composed of eight officers and 43 non-commissioned officers and men. In addition, two N.C.O's have accepted commissions in the Royal Field Artillery, seven N.C.O's. and men have remained at work in South Africa, Lieut. J. H. Stubbs and Lance-Corporal C. H. R. Thorn are in hospital, and four, whose names are recorded above, died at the post of duty.

The President, having read a letter from Lord Kelvin, expressing his regret that he was unable to be present, and his pride in being associated with the corps as Honorary Colonel, proceeded to read an address of welcome to the detachment in the name of the Institution. Prof. Perry declared that Dr. John Hopkinson had created the germ of what would probably become the greatest and best line of defence of the Empire; the detachment had carried out the first experiment, giving up positions and chances of promotion at a sacrifice which was particularly well appreciated by the Institution. After a feeling reference to the lives laid down in their country's service, the President complimented the detachment on the extreme value of the services they had rendered, and on the common sense, resourcefulness, and moral courage which they had evinced, and which reflected honour upon the profession which they so worthily represented.

General Salmond prophesied a great future for the Electrical Engineer Volunteers, and gave an interesting *résumé* of the formation and training of the corps, and of its equipment for the South African campaign. The volunteers themselves asked that Captain Lloyd, who was largely responsible for their training, should accompany them. The corps had done exceedingly good work, and had had a share of the fighting.

Lieut.-Colonel Crompton, who responded for the detachment, was received with loud applause, and expressed his gratification with the magnificent reception given to the volunteers. A close attachment sprang up between them and the Royal Engineers, in the reconstruction of the railways in Orange River Colony; the work was not without excitement, with De Wet swooping down at times. Some details of the operations of the corps were given, but these may be deferred until the publication of the lecture delivered yesterday. Lieut.-Colonel Crompton then presented to the Institution a Boer projector and dynamo exploder, which the corps had brought home as trophies.

Captain Lloyd also responded, and said he was proud to have taken out the first and brought back the last section of highly trained scientific men. The harmony and cordial co-operation between the various branches of the forces called

for special remark, and a well-merited compliment was paid to the civilian electrical engineers of South Africa.

Lieut.-Colonel Crompton then exhibited a series of lantern slides illustrating the work of the corps, some of which were lent by the ELECTRICAL REVIEW, and have already appeared in our columns.

The rest of the evening was spent in pleasant intercourse between the men and their friends, while a programme of instrumental music, directed by Lieut. J. Sommer, R.E., and of vocal music, directed by Mr. A. E. Izard, was performed. The President, later, proposed a vote of thanks to Mr. Frank Rendle and Mr. Neil Forsyth, for having kindly lent the Opera House for the purpose of the reception; needless to say, the vote was carried by acclamation.

The function was in every sense a great success, and afforded a most appropriate termination to the proceedings in honour of the South African Contingent.

CORRESPONDENCE.

The Ethics of Electrical Engineering.

In a journal devoted to local government matters there appears this week a note stating that Mr. ——, the consulting and resident electrical engineer to the —— Corporation, has obtained permission from the Corporation to act as consulting engineer to other corporations, &c. This journal also advises municipal bodies to consult this gentleman upon any schemes they propose carrying out.

Now, it is very seldom that anything appears in your journal on the ethics of electrical engineering, except when you have expressed your opinion upon a quarrel between two rival consultants.

You have some weeks ago taken up cudgels on behalf of contractors against the employment of unskilled men and the dealing direct of manufacturers with clients.

Your criticisms of the current specifications are very useful, and must tend to the production of specifications which shall, in addition to being to the credit of the consultant in particular, also be beneficial to the manufacturers and ratepayers.

But so far I do not think you have touched upon the question of municipal electrical engineers acting as advisers to other municipalities, and it would be interesting to have your opinion in an editorial.

What chance is there for young consultants when they have to compete under such conditions, and is it fair to the municipal authorities who allow their engineer to do work for other public bodies?

Does it not also look *infra dig.* for them to have to augment their salaries by having to do this, or that their Corporations did not consider their services valuable enough to pay them salaries sufficient to keep up their positions?

Does one ever hear of the gas engineer, surveyor, sewage engineer, or water engineer of one Corporation being engaged by other Corporations to advise them? If not, then what is the difference in status between these and a borough resident electrical engineer, and why create a precedent?

In your last week's issue there appears the name of a borough resident electrical engineer as one of the directors of a company which is seeking powers for lighting several towns. Is this consistent with his position, and how can he attend to the interests of his own municipal authority?

Does not every borough electrical engineer sign an agreement to devote the whole of his time to the service of his Corporation?

I know of one town where the borough electrical engineer, who has a large tramway undertaking in hand, devotes a large amount of his time to bothering with 10 or 20-light wiring jobs for private consumers in the town, getting out specifications and supervising work.

The borough electrical engineer of a town in the North is allowed by his Council to take on outside consulting work, and has a large lighting and tramway undertaking in his own town to attend to. This town I will call X. Some 12 months ago I prepared a scheme for a district council, a sub-committee of which was appointed to visit several towns, one of which was X. Two days after their visit to X, the clerk to the district council received a letter from the borough electrical engineer offering his services as consultant!

I am glad to say that this district council refused his offer, as the principle was unsound; and why should they engage the services of someone who was being well paid for looking after the interests of his own ratepayers?

You will notice that I have only touched upon the question of a resident engineer advising other local authorities, and not on any new, or extension works, in his own town.

I think, Sirs, you will deem this matter of sufficient importance to give it your unbiassed and, as usual, fair consideration.

Consultant.

P.S.—You will, no doubt, remember the words of a councillor at an important city in the North a few months ago, who, when the borough electrical engineer wanted to engage in electric company promoting, said that he (the B.E.E.) must either give all his time to the Council or "shunt." He did the latter. How is it such councillors are not found on other corporations who have some business insight in them in this direction?

110 v. 220-volt Supply.

Referring to my letter of November 26th, inquiring for some further data on above subject, I am sorry Mr. Boot has not yet been able to publish same, although I notice in your issue of December 7th a statement of accounts of Tunbridge Wells station, which may be intended by him to supply the necessary blank in his previous articles.

On comparing the figures given in these accounts I find that although the gross revenue in 1899 shows a reduction amounting to a little over 24 per cent. as compared with 1898, the total cost of production was practically the same in both years, and the gross profits were reduced by an amount equal to nearly 20 per cent.

It will therefore be evident that the saving to consumer was not brought about by changing over from 110 volts to 220 volts, but was altogether due to the alteration in method of charging for current, as, indeed, one having a knowledge of the subject would naturally suppose.

Thus your remarks in "Notes" of issue of November 16th, that "Surely this constitutes a new and powerful argument to induce consumers to accept the change" is, I think, premature, and, to say the least, misleading to the consumer, who is not usually aware of the extra expense entailed by him in many ways, principally in upkeep of lamps, and the more stringent regulations of the supply companies, who reap the only apparent benefit, *i.e.*, the greater lamp-carrying capacity of their existing street mains.

T. H. McMurray.

[Our correspondent should in fairness have quoted the sentence immediately following his extract from our note, in which we asked Mr. Boot for further particulars as to the system and rate of charging in the two cases.

We believe that almost invariably the price to consumers is lowered when the pressure is raised, as was done at Tunbridge Wells. Seeing that the distributing apparatus costs something like half the total capital outlay, and that the change enables, roughly, four times as many lamps to be supplied without material increase in this item except for service connections, it is clear that the price ought to be lowered.—EDS. ELEC. REV.]

Information Wanted.

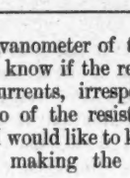
Although living in a district where a large quantity of electric appliances are made, I am a perfect ignoramus on the question of electric lighting and its application to isolated houses; I mean where they have no public supply to draw upon.

I am a farmer, and for the purposes of food preparation for my stock, I have a small 3-H.P. steam engine, but propose replacing it with a 6½-B.H.P. oil engine, and thought, if possible, I should like to add the electric lighting of my house and premises to its work. Would some of your correspondents kindly tell me (1) if this is feasible; (2) what other

apparatus beyond the engine I should require; (3) approximate cost of same, also of installation, say, at per lamp. Any information on the subject will be gratefully received. Thanking you for inserting my inquiry,—

A Complete Novice.

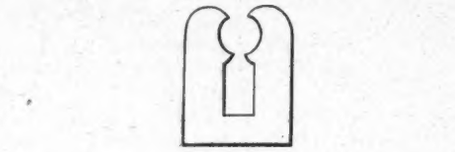
I am making a galvanometer of the Deprez d'Arsonval type, and would like to know if the readings on the scale are proportional to the currents, irrespective of the size and strength of magnet, also of the resistance of the coil, and mode of suspension. I would like to know also if there would be any advantage in making the magnet this shape—



with an iron ball to intensify the field, and a coil made circular, to fit the poles; also would the deflections be proportionate? The third and last question is: Do you know whether, in the treatment of rheumatism, the constant current from cells alone, or the mild shocks from an induction coil, have had the best effects?

Sparks.

[The readings on the scale of a d'Arsonval galvanometer, with a spot of light, are exceedingly nearly proportional to the current strength, irrespective of the dimensions, &c. The pattern suggested, with an iron ball inside the coil, is not nearly so easy to make or so satisfactory in use as the narrow coil type devised by Mr. Mather, and shown in the



Section. Plan.

accompanying sketches. Information on the subject will be found in the Electrical Review, Vol. xxvi., p. 391; Vol. xxx., pp. 64 and 788, and elsewhere.

We regret that we are unable to deal with the last query; perhaps one of our readers will kindly reply.—Eds. Elec. Rev.]

THE PROPOSED ELECTRICAL CONTRACTORS' ASSOCIATION.

We have received a good deal of correspondence relating to a proposed Electrical Contractors' Association, some of which has already been printed in our "Correspondence" columns. We now print a further instalment of letters, which give expression to the views held by a number of electrical contractors who are anxious to protect their own interests. We would especially draw attention to the letter of Mr. Rowland E. Dixon, of Leeds, which urges all interested to join in the movement, so that the Association may be a strong one. Perhaps those who are prepared to attend a meeting to be held in London, say about February 1st, will send a letter to this effect to "Convener," care of Electrical Review.

Re Electrical Contractors' Association.

With reference to the correspondence you have kindly inserted in your paper on the above subject, I think, in view of the very strong feeling of dissatisfaction amongst the electric lighting contractors and the unsatisfactory condition of the trade, that a suggested meeting should be called in London, say February 1st, or any other convenient date.

It is very necessary that this meeting should be attended from all over the country, as unless the movement is universal as regards England, the Association would not be strong enough to bring pressure to bear upon several manufacturers who will credit anybody passing as an electrical engineer and direct to consumers. Other points for the Association to take up are registration of wiremen, equitable clauses in consulting engineers' specifications, &c.

Anticipating a representative meeting, further notes are unnecessary if such a meeting be convened, asking all contractors to forward their names under the two questions:—(*a*) Will you join the Association and attend the meeting? (*b*) Will you join the Association if unable to attend the meeting?

I would suggest that the Association be formed on the following lines, having a general meeting yearly or half-yearly in the different large centres, and the country to be divided into districts, having meetings of local members monthly.

I sincerely hope the calling of this meeting will be cordially responded to, and that all contractors will take the matter up energetically by using their local influence to induce other contractors to join and attend the meeting and form a strong Association.

Rowland E. Dixon.

Leeds, *December 15th*, 1900.

A Cheltenham electrical engineer writes:—"*Re* proposal to form a Wiring Contractors' Association, I am strongly in favour of such a scheme, and, in fact, some years ago attempted to get one up, but owing to want of support, the matter fell through. I think that, owing to various causes, the starting of such an association is now absolutely necessary, and I should be glad if you would kindly add my name to those who are supporting the scheme."

A firm of electrical and mechanical engineers in the City writes:—"It seems to us an almost hopeless thing for contractors to hope for a legitimate profit whilst business is conducted upon present principles. It is not merely a question whether manufacturers of electrical apparatus and accessories shall supply people who are not in the trade, it is rather a question whether people who pay their accounts regularly and promptly shall enjoy no privilege which is not extended to an impecunious plumber or blacksmith who assumes the trading title of 'electrical engineer.' As electrical contracting stands at the present moment, one must conclude that it is not a question of making profits by trade, but of living upon the credit and reputation which is attached to the carrying out of certain work.

"It is highly desirable that at the earliest possible moment, a Contractors' Association be formed, a strong and resolute association, one that can be in a position to force its conditions, not merely upon the manufacturers of material, but upon councils and local authorities for whose work they tender. It seems to us that contractors should have some opportunity of protesting unitedly against the dictatorship of local engineers, or the nominee of local authorities. It is known to many contractors that most specifications are so worded that everything is left to the discrimination of an appointed engineer, whose chief care is to improve his position in the eyes of those who retain him, at the expense of the contractor. In consequence, no engineer, in our opinion, should be sole arbiter as to the way in which the contract shall in its minute details be carried out, or there should be some definite standard of work. We have a strong instance in point. In one of our County Council contracts it was stated that everything should be done to the satisfaction of the engineer, what was to be done was not definitely described. Naturally, we concluded that the same methods, the same systems, and the same principles would be observed as in all other large contracts that we had been connected with, but that very dangerous clause, 'to the satisfaction of the engineer,' continually obtruded itself, and the consequence is, we are obliged to do work, we understand, without any hope of appeal against it, costing three times what we estimate it would cost. Plugging walls every 15 inches with plugs squared accurately is a feature in this contract, and we venture to state that no building in this country has ever been plugged for the fixing of casing to such an abnormal extent, as the engineer who supervises our County Council contract requires. This, however, is only one of many objections; we maintain that public bodies in issuing their specifications should minutely detail what they require, so that contract work shall not be a dangerous speculation."

"Another matter suggests itself: Contractors should have some command over the labour which they engage. There is a growing inclination to sub-divide work; various tradesmen consider that they should do everything that is to be done with the material that belongs to their trade. A labourer must not break a brick or cut a hole in a brick—it is bricklayers' work; to chop a peg is carpenters' work; and upon one of our contracts this trade union jealousy has reached such a pitch that, in order to avoid a serious strike, which would have thrown some 2,000 men out of employment, and have brought serious loss upon some of our co-contractors, we agreed that plasterers should remove the plaster from the face of walls before the bricklayers cut holes in the brickwork for the carpenters to fix plugs therein. We should be perfectly willing to co-operate in endeavouring to secure for contractors the privileges and rights which, at the present time, very few of them, we are sorry to say, are anxious to obtain."

A Failsworth firm writes:—"We think an Electrical Contractors

Association a very desirable thing for mutual protection and advancement, and would be willing to join.

"As the distance to any one centre in the country would be too great to travel to ordinary meetings, it would be desirable to have district centres. We should certainly have a centre for the Manchester district."

A firm of contractors at Birmingham says:—"The proposed Association as above meets with our hearty approval, and if carried through should be a great benefit to the trade in a variety of ways, viz., the elimination of the jerry contractor and his kindred, the registration of competent workmen, and the bringing before manufacturers the necessity of running straight. It is notorious that many suppliers do in many cases go behind contractors, and quote their customers the same terms as they give to the trade. To give an instance of this: we recently quoted a customer, a restaurant keeper, for a pair of enclosed lamps of a certain well-known make; our customer writes to his insurance company (in the North) asking if they have any objection to offer to the lamp. By some means the maker's representative is informed, and promptly sends a list to our customer quoting him 2/3 of trade discount off, and secures the order. Whilst one contractor can have but little influence to check this real and growing grievance, an Association could exert a heavy pressure, and teach effectively to suppliers the fact that it is not a wise thing to run with the hare and hunt with the hounds. Again, something might be done towards standardising accessories, &c. In short, such an Association, if wisely managed, cannot help but be of great gain to our trade."

A Southport firm writes:—"In my opinion such an Association, formed on the lines of, say, the Master Builders' Association, with meeting places in the large centres throughout the country, is the only solution to the many difficulties under which a legitimate contractor has to labour at the present time. There are many matters on which such an Association would, no doubt, have a very beneficial effect, such, for instance, as the specifications issued by consulting engineers and municipal engineers, which very often are too vague; the action of municipalities entering into competition with contractors, which often is very unfair competition; the control of the wholesale houses, many of whom will sell to large consumers, who, by the way, should be the contractor's best customers, at as good terms as the contractor. Then there is our old friend the jerry wireman, who requires special attention. I should be pleased to attend a meeting of contractors to consider the matter, and subscribe my address, so that anyone who is in favour of same may communicate with me direct."

"B," a City of London electrical engineer, "entirely agrees with the remarks of 'A Contractor' in a recent issue," and says "I think the remedy he suggests is the best method of improving the existing conditions of things. A recent specification I tendered to contained many conditions of an unfair nature, more or less similar to those frequently met with. The people for whom this work was to be done formed a committee, who employed an architect, who in turn employed a consulting engineer who was the chief engineer at the supply station. A clause in the specification stated that all work and material must be such as to satisfy the demands of the architect, the chief supply engineer, the Fire Insurance Company and the committee. The first three of these parties had power to condemn the use of anything or everthing without assigning a reason. Another clause made the said engineer sole arbitrator in case of any dispute arising. The work under this specification might be carried out with the highest skill, the best material procurable, and within the time limit, and pass the most stringent tests, and yet, according to the terms under which he works, the contractor might be refused payment. If the architect, or his proxy, or the Insurance Company, or the central station engineer disagreed amongst themselves, all the contractor could do would be to stand by and await the pleasure of their agreement.

"A matter it would be well, perhaps, to consider is whether an architect should be at liberty to buy electric light fittings at trade price and supply them directly to his client at this price—a method occasionally adopted.

"Another undesirable form of competition exists in the practice, not altogether uncommon, of a superior wireman employed by a firm in a district where there may be some scope for work, canvassing the inhabitants in his own name and underselling his own employer. There are men who not infrequently so endeavour to 'run with the hare and hunt with the hounds.' They have no establishment charges, are often financed by the customer, and are absolutely irresponsible. If anything is subsequently found wrong with their work, they themselves have probably disappeared from the neighbourhood, having been engaged by another firm in a different part of the country; even if they were found, no damages could be obtained from them. The names of such men should be circulated amongst all allied firms, and the man convicted of such dealing, however good workman he may be, should be refused any further work by these firms.

"I feel sure that some such method as that suggested by 'A Contractor' is the only way of effectually dealing with the present condition of things."

A Dewsbury electrical engineer says: "I should be very glad to subscribe to and become a member of an Association to (1) prevent manufacturers from selling goods to contractors' customers or others outside the trade at trade prices; (2) contractors to be registered, also fittings, &c.; (3) certification of wiremen and fixed minimum wage. I should be glad to attend any meeting in this district, or to do anything in my power to enable the scheme to succeed."

Another London firm of electrical contractors is very strongly in favour of such an Association, and would suggest that if communications are received from some of the leading firms, a general meeting should be called to discuss the many grievances from which the trade is now suffering.

Messrs. G. N. C. Mann & Co., Norwich, write:—"As already stated in your columns, we shall be only too delighted to join in and to do anything in our power to further the proposed Association. Our views are to a large extent similar to those of your other correspondents, and we need not repeat them."

"J. W. B." says:—"'A Contractor's' letter, published in your issue of November 9th, contains some suggestions of value toward this subject, but I would draw the attention of all who are giving the matter serious thought to the question of fixing minimum selling rates, as being a very dangerous expedient, and economically wrong in principle. Let any Association which may be formed check its members by establishing minimum standards of quality and simplicity in material and workmanship, which should be such as to permit of work being carried out at the lowest figures consistent with permanency and safety, but beyond this they should leave the natural course of events to eliminate such of their members as may, through ignorance or folly, execute work at prices which entail loss to themselves. The principle of fixing limits to selling rates is attractive, but scientifically wrong, and has failed in the case of commodities for which there is a much greater demand than installed electrical equipments."

"Nobilis" writes:—"There is great need of an Association of Contractors such as 'Contractor' writes of. In this borough it would surprise you what a number of electricians have sprung up like mushrooms within the last 12 months, one among them being a retired policeman. I suppose he gained his experience of electricity by pushing the servants' bell while calling on the cook. To all these the Corporation have sent to inquire their prices for free wiring, including gasfitters, who see a large portion of their living gone and take up electric lighting to make it up. Of all these the average has been taken as the basis of the Corporation's prices, and the enclosed form is the result of their deliberations. If there was an Association of Contractors this could not have happened, and the Council, who are so anxious that sweating should not exist in the borough, would have found it impossible to sweat contractors. I heartily agree with the scheme formulated by 'Contractor,' especially relating to manufacturers supplying at trade prices to customers, and I should be one of the first to subscribe my name."

We have also received several other letters on the same subject, but not for publication.

PHYSICAL SOCIETY.

Ordinary meeting held in the Physical Laboratory of the Royal College of Science (by invitation of Prof. Rucker) December 14th, 1900.

A paper "On Electric Inertia and the Inertia of Electric Convection" was read by Prof. A. Schuster.

Calculations of self-induction are based on the assumption that the currents which traverse a conductor fill it continuously, the flow being treated as that of an incompressible liquid. The assumption is generally recognised not to hold in the case of electrolytes where electricity is conveyed by a number of irregularly distributed ions. In the immediate neighbourhood of such an ion the magnetic field is many times greater than that calculated on the supposition of continuous distribution, and hence the total magnetic energy is underestimated. What is universally recognised in the case of electrolytes must also be conceded when the current is conveyed by a gas, and the idea is gaining ground that even in solid conductors the current consists of positive and negative electrons moving with different velocities. It is the object of the paper to calculate the additional terms which become necessary for the evaluation of self-induction, and to discuss the possible cases in which the corrections may affect experimental results. The mathematical investigation shows that it is necessary to add a correcting term containing a quantity which may conveniently be called electric inertia. The author has calculated the numerical value of this quantity in the case of a solid conductor and finds it to be about 2×10^{-13} C.G.S. units. It is of the dimensions of a surface. The experiments of Hertz have proved that if electric inertia exists it must be less than 18×10^{-9}. In the case of liquids and gases the electric inertia of the moving ions becomes much more important, and the calculation of self-induction by the ordinary processes gives erroneous results. The introduction of a term representing inertia alters the general equations of electric motion, and the author has applied his modified theory to Leyden jar discharges, the electrodeless discharges of J. J. Thomson, and the electromagnetic theory of light. In the case of electrodeless discharges in a vacuous globe, it is suggested that the absorption of energy may not only be due to the conductivity of the gas, but also to the inertia which it possesses.

A paper "On Magnetic Precession" was then read by the same author.

The most delicate method of investigating the influence of electric inertia is based on the electromotive forces introduced by the motion of conductors carrying electric currents. If electricity behaves like a body possessing inertia, the rotation of a body through which currents pass should affect the flow of these currents in the same manner as the earth's rotation affects the direction of currents of air. If the earth's magnetism is due to electric currents, it is interesting to see if the effects of inertia can explain the secular variation. The investigation shows that a magnetic precession of the character of the secular variation would be produced, but that the precession would be very much slower than the varia-

tions actually observed. The subject is worked out mathematically, dealing first with the case of currents in a spherical shell, and then extending the result to the case of a solid sphere. The calculated period of a cycle comes out as 7×10^{14} years. If the currents were confined to a thin slice of the earth, the time would be reduced to about 14×10^{6} years. To produce the actual period of the secular change, the current sheet would have to be of molecular dimensions. This suggests the possibility of the phenomenon of secular variation being rather of a molecular than a molar character.

Prof. Rucker congratulated the author upon his attempt to solve the problem of terrestrial magnetism, and expressed the hope that further calculation would throw more light upon this difficult subject.

Mr. Blakesley asked if the time of the secular variation would be altered if the interior of the earth were liquid or solid?

The Chairman observed that the precession was rapid in the case of a thin layer of gas, and mentioned J. J. Thomson's notion that the electrons were thrown off by centrifugal force and formed a molecular layer. Hertz, in his experiments on electricity, had looked for material inertia besides electro-magnetic inertia. In the present theory the distinction disappears, and there is only one inertia, and that electro-magnetic.

Prof. Ayrton said if the two forms of inertia were electro-magnetic, he would like to know why in detecting the second form it was necessary to associate it with an absorption of energy, as in the case of an electrodeless discharge. In the case of ordinary self-induction there is no absorption of energy, and if there is absorption in the second form and if they are both electro-magnetic, he would like to know the difference between the two.

Prof. Schuster, replying to Mr. Blakesley, said that if the interior of the earth were treated as liquid the period of the cycle would be about 100 times less. In reply to Prof. Ayrton he said he had only cited one experiment to show that a phenomenon explained by the gas being a good conductor could also be explained by its electric inertia. It was impossible to say in general whether self-induction caused an absorption of energy or not.

Prof. A. W. Rucker read a paper "On the Magnetic Field Produced by Electric Tramways."

Taking the case of a tramway in which the current flows along a trolley wire from the power house, and returns partly through the rails and partly as earth currents, the author has shown that the vertical disturbing force at any point is due to the currents in the feeders and rails, and that the earth currents affect the horizontal force only. Experiment shows that it is chiefly the vertical force instruments which are affected by the establishment of an electric railway, and since this disturbance is due to the wires and rails, it is impossible for an observatory to be protected by rivers or other natural features of the district. A preliminary investigation is based on the assumption that the trolley wires and rails are insulated conductors, and that a fraction of the whole current returns along the rails to the generator. The effect of the railway at a distant point is due to the difference of the current in the trolley wire, and the hypothetical uniform rail current, the effect of which, at the point considered, is equivalent to the actual rail current, which varies from point to point. It is thus shown that the disturbance increases with the length of the tramway, and for a tramway of given length the disturbance is a maximum at points on a line perpendicular to and bisecting it. Experiments made at Stockton on the magnitude of the disturbing force gave, with the vertical force instrument, a leakage of 16·3 per cent., and with the horizontal force instrument, a leakage of 15·9 per cent.; a fairly close agreement. The assumption that the terminals of the line are above and below the average potential of the earth by the same amount respectively, and that the leakage at any point is proportional to the potential difference between the rail and the earth, leads to the ordinary theory of a Fourier bar. This more accurate assumption has been developed and applied to the results obtained at Stockton. The leakage, as calculated from the amperes and volts, comes out as 20 per cent. The calculation of the disturbing vertical force gives $10{\cdot}5 \times 10^{-5}$ C.G.S. units, which is in fair agreement with the value 7×10^{-5} actually observed. In conclusion, it is pointed out that for practical purposes it is sufficient to deal with the average return current through the rails, the formulæ for which are quite simple.

Dr. R. T. Glazebrook read some "Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents."

In this paper the author has thrown the extended formula, obtained by Prof. Rucker in the previous paper, into a workable form, and has tabulated numbers which show at what distances the disturbances are negligible for tramways of different lengths.

Prof. R. Threlfall exhibited and described a "Quartz-Thread Gravity Balance."

Mr. Watson exhibited a set of half-seconds pendulums.

The Society then adjourned until January 25th, 1901.

LEGAL.

Wolverhampton Electric Trams.

Before Mr. Justice Joyce, in the Chancery Division on Tuesday, the case of the Mayor and Corporation of Wolverhampton *v.* British Electric Traction Company, Limited, was mentioned.

Mr. Hughes, Q.C., who represented the Corporation, said his Lordship would remember that this action was brought to enforce specific performance of a contract contained in an Act of Parliament for the sale of the defendants' tramway undertaking within the borough of Wolverhampton to the Corporation, and was argued some few weeks ago. His Lordship's decision was that the Corporation was entitled to specific performance, and that, in fact, was not really in dispute in the trial. The defendants, however, contended that they were entitled to running powers, and the question which now arose was as to whether interest was payable from the date upon which the contract was to have been completed. The learned Registrar said that the question of interest could not be left open owing to the form in which the judgment was entered. He therefore asked his Lordship to fix a day upon which this point left open could be discussed.

Mr. Justice Joyce: I will hear the arguments on Thursday.

The City of London Electric Lighting Company *v.* The Mayor and Corporation of London.

In the Court of Appeal on Monday, before Lords Justices Rigby, Vaughan Williams and Romer, application was made that this appeal, which was in the day's list for hearing, might stand over for the convenience of counsel.

Lord Justice Rigby protested against the numerous applications which were made to postpone the hearing of cases after they had appeared in the lists. For the future no change whatever would be made in the lists.

Counsel said the application was for the convenience of Mr. Cripps, Q.C., and Mr. Swinfen Eady, Q.C., but he might say that the case was a heavy one and would occupy at least two days.

Lord Justice Rigby: I don't think any trouble is taken about these matters. Counsel seem to think they will always get consideration, even though the cases are in the paper, and the Court is hampered in its work. It is, however, an argument in your favour, that the hearing of the case now may be inconvenient to us, and on that ground, and on that ground alone, we will allow the case to stand over until the next sittings.

BUSINESS NOTES.

Books Received.—"Practical Lessons in Metal Turning," by P. Marshall. London: Dawbarn & Ward, Limited. 2s. net.

"Principles of Magnetism and Electricity," by P. L. Gray. London: Methuen & Co. 3s. 6d.

"Calvert's Mechanics' Almanack." London: John Heywood. 4d.

"The Practical Electrician's Pocket-Book for 1901," edited by H. T. Crewe. London: S. Rentell & Co. 1s.

British India Tariffs.—The Board of Trade have received from the India Office copy of a Customs circular stating that dynamos, accumulators, motors and electric fans are to be treated, for tariff purposes, as "machinery," and, as such, exempted from import duty under No. 14 of Schedule IV. of the Indian Tariff Act, VIII. of 1894, read with the notification No. 3,192, dated July 12th, 1899. Some of these articles if very small and intended merely for use in laboratories might, perhaps, be fairly regarded as "appliances," but it would be difficult to draw the line between the two classes, and the Government of India consider that it will be better to treat them all as "machinery." This rule applies only to the articles named. Electric lights (? lamps) and cables will continue to be treated as "appliances," and be liable to import duty under No. 49 of Schedule IV.—*Board of Trade Journal.*

Cults Nuisance Case.—On appeal, Sheriff Crawford has confirmed Sheriff-Substitute Burnet's judgment, finding that the electric lighting station at Cults, Aberdeen, constitutes a nuisance, and grants interdict against its continuance, it having been stated at the bar that the defenders did not intend to adopt remedial measures. The case is to be appealed to the Court of Session.

Diary.—Messrs. T. Bolton & Sons have issued a very neat pocket diary and note-book for 1901. It is of convenient size, and allows room for a few brief notes in each day's space.

Dissolutions and Liquidations.—A petition for the winding-up of the Rhea Insulite Syndicate has been presented to the Courts by Volenite, Limited, and will be heard in London on January 16th.

The Macroom and District Electric Lighting Syndicate, of Manchester, is winding-up voluntarily, as it cannot continue its business because of its liabilities. Mr. Henry Shaw, of Rosamond Street East, Manchester, is liquidator, and all particulars of debts, &c., should be sent to him by January 29th.

Messrs. D. Urquhart and J. M. Small (Urquhart & Small, consulting and electrical engineers, of 17, Victoria Street, Westminster) have dissolved partnership. Debts will be attended to by Mr. Small.

Electric Light and Insurance.—The Fine Art and General Insurance Company, Limited, announces a new departure in its business. Insurance companies have not been, as a rule, over anxious to recognise the value of electric lighting in lessening fire hazard, but that the Fine Art Company is fully alive on this point is evident from a concession which it is now making upon premises

where such light is used. It grants substantial reductions, seldom less than 10 per cent. off the current rates in such cases where the work has been suitably carried out by fully qualified and experienced engineers. This company, it will be remembered, was an exception to the rule when certain other insurance companies, a few years ago, were charging extortionate premiums, in the belief that because there had been one or two fires in London, central electric lighting stations were dangerous risks. The Fine Art Company has since secured the insurances of the principal municipal electric lighting stations throughout the country, and many company works as well, the amount covered in many instances ranging from £25,000 to £50,000. A practical testimonial such as the existence of this preferential rate will be a help to electric wiring contractors and fitters.

Fire.—Late last Saturday night a disastrous fire broke out at the premises of Hooper's Telegraph and India-Rubber Works, Limited, at Millwall. Before the firemen arrived the mill and testing room were alight, and soon afterwards the stiffish breeze which was blowing drove the flames across to two more large structures, used as engine rooms and machine shops. When it was seen that the local fire brigades were unable to cope with the outbreak, Commander Wells despatched a force of 21 steamers and 130 firemen to the scene, and proceeded to the fire himself to direct the operations. The new fire float *Alpha* was ordered to proceed from her moorings at Blackfriars Bridge to Millwall Docks, and similar orders were given to the float at Cherry Garden Pier, Rotherhithe. At midnight the fire was at its height, and was being attacked both from the land side and from the River. At that time the roofs of premises belonging to Messrs. W. F. Dennis & Co., engineers, and Messrs. Rait & Gardiner, engineers, ignited, and it seemed at one time as if the whole of these premises would become involved. It seems that the fire took a course right through the centre of the works, leaving the shops on either side untouched. The cable machines, the mill, and the testing room were most seriously affected, but the braiding machines, cable tanks, and rubber goods factory were not touched. A large amount of electric lighting cable was being turned out, and other very pressing orders were in hand; in fact, a large staff was engaged at the works until early in the evening; cables for the War Office and the Great Northern Telegraph Company were practically ready for delivery, but were destroyed. Business is proceeding in certain departments, and although it will be some few weeks before the works are quite right again, all orders will be attended to as promptly as possible.

The Hammond Joint Box.—We are informed that the Improved Electric Glow Lamp Company are taking up the sole and exclusive rights of the Hammond joint box, which was recently described in these columns.

The Robey Engine at the Paris Exhibition.—Messrs. Robey & Co., Limited, of Lincoln, at the close of the Paris Exhibition have been awarded a Gold Medal for the excellent work done by the engine of 550 H.P. exhibited by them for supplying electric light and power to the Exhibition. It is worthy of notice that only three English engineers undertook to supply electricity, and the highly satisfactory manner in which the engine fulfilled all demands made on it has resulted in the above award. We are informed that during the daily runs at the Exhibition there was no stoppage of the engine from any cause whatever, a distinction which is shared by only one other engine of the many exhibited.

Trade Announcements.—The British Electric Meter Company, Limited, has removed its secretarial offices to Wardrobe Chambers, 146A, Queen Victoria Street, E.C.

Mr. A. P. Lundberg has appointed Mr. Edward Unsworth, of 8, Greenhill Street, Greenheys, Manchester, as his representative for Lancashire.

ELECTRIC LIGHT AND POWER NOTES.

Aspull.—Messrs. Lacey, Clirehugh & Sillar have been instructed to report to the Council on the question of electric lighting.

Barnstaple.—Public feeling in the town is strongly in favour of an electric lighting scheme being carried through by the municipality; a report, which has been submitted to the T.C., shows that the probable cost would be £13,500, water-power being made use of.

Bingley.—The D.C. does not approve of the Yorkshire Electric Power Bill.

Brighton.—An inquiry into the application of the T.C. to the L.G.B., for permission to borrow another £56,500 capital, was held last week by Colonel A. G. Durnford, R.E. Mr. Christie, the resident engineer, presented the details of the estimate. The present plant has a capacity of 147,000 8-C.P. lamps, and there are 150,000 lamps connected, so that the number already exceeds the actual capacity; there is the prospect of a further demand equal to 2,500 lamps for the new pier, and 11,000 for the tramways. New customers are coming in at the rate of 400 or 500 a year, and the increase of business all over may be taken at about 16 per cent. on that of previous years.

Chesham.—The T.C. is to apply for an electric lighting prov. order.

Darlington.—The new electric lighting system, which has been undertaken by the Corporation at a cost of £26,000 was formally opened on Monday. The supply was switched on by Alderman Barron, chairman of the Electric Lighting Committee The works are capable of supplying about 7,000 8-C.P. lamps.

Dublin.—The tenders for the erection of the generating station at the Pigeon House Fort range from £41,000 upwards. The original estimate was £20,000.

France.—The Municipal Council of Brive, France, has under consideration the execution of the following works:—An electric station, the motive power for which is to be supplied by one of the numerous waterfalls in the neighbourhood of the town; an electric tramway service; the replacement of the gas service by electric light. A competition will be opened for suggestive schemes, and will be decided before the end of May.

Halifax.—The bursting of a pipe at the electricity works, to which we referred last week, resulted in the death of a boiler house attendant from shock due to severe scalding. In evidence at the inquest, Mr. Street, the electrical engineer, said that he found a crack all the way round the main steam pipe in the boiler house, over one of the economisers. The crack was close to a flange. The pipe had been in use six years; it was made of cast-iron. There was a spongy fault in the metal.

Heaton Norris.—This district is included in the area over which the Manchester City Council possesses lighting powers, but it may be years before Manchester is ready to supply it with electricity. The D.C., therefore, is getting anxious, especially as Stockport supplies right up to the Heaton Norris boundary, and would be only too glad to supply the latter also. The Manchester Electricity Committee is to make definite proposals shortly.

Hebburn.—The D.C. is asking various electric power companies upon what conditions they can supply energy for Hebburn.

Holland.—The establishment of a large central station for the electric lighting of the harbour and the public streets has just been decided upon by the municipal authorities of Amsterdam.

Hornsey.—The Board of Trade have informed the Hornsey District Council that they will include that portion of the parish of Clerkenwell now transferred to Hornsey in the Bill which they are presenting to the House of Commons, to make the electric lighting areas co-terminous with the borough Councils' areas. The District Council has declined to accept the offer of the North Metropolitan Electrical Company.

Ince.—A report on the electric lighting question is being furnished to the Council by Messrs. Lacey, Clirehugh & Sillar.

Inverness.—The T.C. has reopened the electric lighting question. Negotiations have been set on foot with a view to obtaining water-power supply from the Canal Commissioners.

Keighley. — The Electricity Committee is about to appoint the staff for the new electricity works.

Kimberley.—The public electric light installation, which was started at the beginning of 1899, and would have been completed by February of this year but for the outbreak of the war, was formally inaugurated on October 15th. According to the *B. and S. A. Export Gazette*, the works have cost £25,000, and were carried out by Messrs. Reunert & Lenz, Durban and Johannesburg, the plant, a portion of which is yet on the way, comprising the following:—Two 212-H.P. boilers, supplied by Messrs. Babcock & Wilcox; a 154-tube Green economiser; Worthington feed pumps and condenser; a Worthington cooling tower; two 2,200-H.P. engines supplied by Messrs. Seymour & Macintosh, for driving two direct coupled generators; two 2½-ton overhead tramways for the engine room, and an eight-slab marble switchboard, fitted with 28 instruments. Accumulators are to be provided at an additional outlay of £5,000. The present capacity of the plant is 5,000 16-C.P. lamps, but an increase on this, it is anticipated, will be necessary in the near future. A portion of the work was prosecuted during the siege, and the trenching operations were interpreted by the Boers to be connected with the laying of dynamite mines for their special behoof.

Lytham.—The U.D.C. wants to reduce the outlay for an electric lighting installation, and is conferring with an electrical engineer on this point.

Midsomer Norton.—The U.D.C. has agreed to combine with the Radstock D.C. in the consideration of a joint electric scheme.

Moffat.—Mr. W. G. Forman, electrical engineer, Moffat, has submitted a report on a scheme for the supply of electric light by means of water-power from the Birnock Burn. The Police Commission has approved of the scheme.

Ottawa.—The *Electrical World* says that the development in electrical enterprises at Ottawa, Ont., although of comparatively recent date, has been most rapid. In 1877 the Chaudiere Electric Light and Power Company was organised and was practically the beginning of the large system which now supplies Ottawa and Hull with electricity for lighting and power. The first dynamo had a capacity of 250 incandescent lights. The dynamos to be installed in the new power house of the Ottawa Electric Company, now under construction, have a capacity of 15,000 lights each. In 1895 an amalgamation of the Chaudiere, the Standard and the Ottawa Companies was effected, under the name of the Ottawa

Electric Company, whose business has developed enormously, until to-day it has installed 700 arc lights and about 100,000 incandescent lights, being a larger number, *per capita*, than any other city in the world. The history of the Ottawa Electric Street Railway Company is very modern, but its growth has not been less remarkable than that of the lighting interests of the city.

Pudsey.—The Independent Labour party have petitioned the T.C. to oppose the granting of Parliamentary powers to the Electric Power Distribution Syndicate on the ground that a combination of the local authorities could do the work more effectively. It is understood that the Council are taking steps to prevent any company or person coming within the township for the purpose.

Rhyl.—At last the agreement with the Light Railway Company has been signed and sealed, and the Council are now bound down to supply electric current to the tramway by April 1st, 1902.

Rochester.—The Town Council are negotiating with the Rochester, Chatham and District Electric Lighting Company, with a view to purchasing so much of the Company's undertaking as is within the limits of the City. Mr. F. C. Raphael is to value the plant, &c., concerned, and report to the Corporation, when further matters relative to the proposal will be discussed.

Roumania.—Electricity seems to have a very important future before it in Roumania, in the exploitation of petroleum springs. One of the most important installations is that of Sinaia-Campina-Doftana, which is shortly to be increased. The large electrical power house of Sinaia employs the waters of the Prohova and Valea Rea rivers to turn three turbines. The station gives a power of 1,000 H.P., of which 500 is absorbed in the lighting of the town of Sinaia, and the remainder transmitted to Doftana as motive power. The dynamo of the Sinaia station produces current at 240 volts, which is increased to 11,000 volts by being passed through a transformer, and transmitted to Doftana. This station also possesses a steam engine of 150 H.P. in reserve in case of accident to the line or insufficiency of current. In the latter case the current produced at 240 volts is transformed in the same manner. The two currents, that coming from Sinaia and that produced at Doftana, are united and distributed between Campina and Bashtenari. The company intends between now and next autumn to augment the horse-power from 1,000 to 1,700. To attain this object, no definite decision has yet been arrived at. The matter is, however, under discussion, and the company have to decide where to place the new turbine of Sinaia, the new station of Doftana with more powerful machinery, the new steam factory, and where they will catch the water on the Prahava for the new Sinaia turbines. It is expected that a decision will be reached in these matters in a month or two, but up to the present contracts have already been passed for the supply of 1,700 H.P. This power is employed for the boring of petroleum springs, the exploitation of same and for lighting purposes. The advantages of electrical motors over steam engines are indisputable. They are more easily managed, they permit a gain of 30 per cent. of time in the borings and a great economy of labour, and do not necessitate the stoppings frequently inevitable in a country where water is scare. As is well known, when oil wells are sprung, it is always necessary to extinguish all the furnaces in the district for fear of a "brand." There is no such fear with electrical machines. Having this in view, the Société Steana intend to adopt electrical machines throughout.

Southampton.—Colonel H. G. Durnford, one of the L.G.B. inspectors, held an inquiry last week relative to an application by the Borough Council for sanction to borrow £12,000 for purposes of electric lighting.

Southwold.—The Coast Development Company have asked the Council whether in the event of their putting down an installation for public lighting, the Council would approve of their application for a provisional order next year. The Council has called Mr. Warden-Stevens in to guide it in the matter.

Stirling.—The Commissioners have resolved to extend the arc lighting of the town by erecting 30 additional lamps, at an estimated cost of £915. On the recommendation of Prof. Kennedy, the Commissioners have decided also to extend their station by the erection of two Lancashire boilers, two dynamos, feed-water heater, feed pump, and switchboard, at a cost of something like £10,000. Estimates for the extensions are to be invited at once.

Swadlincote.—The Board of Trade having asked whether the D.C. has yet proceeded to act upon its provisional electric lighting order, that body has asked for an extension of time.

Swansea.—The L.G.B. has decided that the application of the Corporation to borrow £10,000 for the purpose of wiring the houses of consumers was *ultra vires*, and the loan therefore could not be sanctioned. The wiring will therefore have to be done by private firms.

The municipal electric lighting works commenced operations last week. The National Electric Wiring Company has consented to certain modifications in the draft agreement with the Corporation for free wiring. One of the changes imposes a fixed charge per lamp instead of a charge per unit. This is as it should be.

The Tyrol.—The application of electricity as a motive power in the Tyrol is being greatly increased by the aid of the numerous large waterfalls which exist in the district. Recently there have been established, especially in the northern Tyrol, several industries employing electrical energy on a large scale. Messrs. Egger & Lüthi, at Kirchbitche, for instance, as well as the firm of A. G. Perlmooser, not only work their cement factories, but also their quarries by the same power. The first factory employs for the production of electric current, turbines developing a power of 300 H.P. The second for the same purpose employs steam engines developing 800 H.P. It is now proposed to instal a new power plant on the Stilluppback, near Mairhofen. It is already decided to light Zell, near Zeller, and Mairhofen and environs with the aid of a power station of 2,000 H.P. Electric current is to be furnished to the valley of the Zeller for the exploitation of the Goldbergwerk, and probably current will also be supplied for the projected railway to the Zillerthal. This enterprise has given place to the formation of a company which has bought the concern from Messrs. Otto Kurz, Electrical Enterprise Bureau, Munich, Innsbruck. These works, as well as numerous others in contemplation, should afford an opportunity to English contractors to earn a name for themselves in this country where German houses have already carried off many important contracts.

Warwick.—The T.C. has rescinded its resolution consenting to the British Electric Traction Company's application for an electric lighting prov. order, as the generating station would not be in Warwick.

Whitehaven.—The T.C. is about to extend the electric lighting undertaking, and application is to be made to the L.G.B. for sanction to borrow £10,000 for the purpose. The lighting of portions of the town has been interrupted of late through defective cables.

Stockton.—It is 10 years since the members of the Stockton Corporation first started to talk of having the streets of the town lighted by electricity, but it was not until Tuesday of this week that Alderman R. Hind, chairman of the Electricity Committee, finally turned on the current from new works which have been erected at a cost of £26,500. Alderman Hind received the invited guests at the Electricity Works, these including the Mayor and Mayoress, several other members of the Corporation and their wives, Mr. Thompson, the representative of the Brush Electrical Engineering Company, and Mr. C. S. Vesey-Brown, electrical adviser. Mr. W. Ford, the manager of the new works, was unfortunately unable to be present, through illness. The Mayor took the chair, and Alderman Hind started one of the engines, after which Mr. Thompson, on behalf of the Brush Company, presented him with a bronze standing lamp as a memento of the event. He congratulated the Corporation upon the great promise of popularity which was before the new works, judging from the demand that had already been made for the light. The Mayoress, at the request of the chairman of the Electricity Committee, turned on the first lights. Subsequently, Alderman Hind gave a brief address, stating that they had already had applications beyond their expectations. Demands had been received from 75 consumers for lights equal to 5,700 8-C.P. lamps, in addition to the street lamps. Mr. C. S. Vesey-Brown gave a technical explanation of the scheme, and the proceedings terminated with votes of thanks.

ELECTRIC TRACTION NOTES.

Bolton.—The following note is reproduced from the *Manchester Evening News* of 14th inst.:—"Something like a sensation has been created in Bolton by the report of the borough engineer, Mr. A. A. Day, on the state of the Bolton tramway system in regard to the lines. When the Government inspection took place, it was suggested by the inspector that the whole of the old lines would require relaying, the cost being estimated variously at from £40,000 to £70,000—expert opinion being nearer the latter than the former. Now Mr. Day reports that he discovers that the gauge varies at different points. Its effects are obviously disastrous to the cars. Oil grooves are 'hammered' out of place as a result of jolting and twisting, the coils of motors are shifted and worn through the insulation, axles have been found to give way through the crystallisation of the steel, wheels have been worn and loosened, and the cars themselves wrenched. In Dover, says the engineer, the difficulty was overcome by 'trueing' the wheels to the gauge, but this is not possible in Bolton, owing to the gauge being true at one point and inaccurate at another, and he advocates the relaying of the whole system as quickly as possible. This does not apply to the new tracks, but it wipes out all idea of profit for a considerable period."

Cardiff.—The Tramways Committee last week considered reports from the town clerk and a sub-committee with reference to the removal of the existing tramways by the company. The sub-committee in their report stated that Mr. Glenn, engineer to the tramway company, had promised to advise his directors to relay the whole of the existing track owned by the company, and make it suitable for electric traction, the work to be done by the company on contract under the supervision of the borough engineer (Mr. W. Harpur) and the electrical engineer (Mr. A. Ellis), provided the present value of the undertakings can be agreed upon. Mr. Glenn would undertake to get the work done in 12 months. The Tramways Committee agreed to this proposal.

Mr. Ellis, the new electrical engineer, recommended that the laying of the cable in Newport Road be postponed for some little time, because it might be advisable to lay a different sort of cable to

that ordered, which was not suitable for continuous current. The cable on hand could be utilised in another way. The Electrical Committee has agreed to this. It was further agreed to change over the supply to that of continuous current as soon as possible, and it was also decided to accept the recommendation in Mr. Ellis's report to the joint committee as to concentrating the plant for lighting and tramways in one place at Roath. Instructions were given to Mr. Ellis to report upon the amount of plant required.

Coventry.—The electric tramcars in Coventry are stated in the daily press to be temporarily converted into post offices at night. Letter boxes are attached to cars running into the town from outlying districts, enabling the public to post letters at the various stoppages *en route*. By this means letters may be posted two hours later than the despatch from the post office in the locality.

East Ham.—On 12th inst. a Board of Trade inquiry was held by Lieut.-Col. von Donop with reference to the Council's application for power to borrow £42,220 for electric tramway purposes.

Italy.—The engineer, Victorio Rivetta, of Rome, has elaborated a project for an electric tram service between Bistagno and Cortemilia Salicato of 1·445 metres gauge. It will be an overhead system and will cost £120,000. The municipal council of Cottemilia has already approved of the project.

Leeds.—One of the large 1,500-H.P. engines for the electric power station is expected to be ready for Easter, when the tram season commences. Two other similar engines are to follow. When these are set up the Corporation will be able to deal with 300 electric cars, instead of the modest 82 supplied from the present plant. The foundations for the new machinery are now being laid. Special traffic arrangements are to be made to meet the great increase of electric cars in the already densely-crowded main thoroughfares of the city. The details of these changes were recently considered by the T.C. We understand that there is not a single route in the city which is not under-carred, and it is to be feared that they will have to remain in that condition until the additional power is supplied. The T.C. has instructed Messrs. Hopkinson & Talbot to prepare specifications for the equipment of the Armley, Wortley, and Stanningley routes, which will complete the electrical tramway system in the city.

We understand that a recommendation will be made at the next meeting of the Council to increase the salary of Mr. Burbridge, electrical tramway engineer, from £400 to £600.

The Leeds T.C. recently established a nightly theatre-car service. It has proved very successful up to the present.

A car left the rails at an awkward curve at the bottom of Cookridge Street, on Tuesday, and caused a half hour's interruption of the service.

Leicester.—The Tramways Sub-committee has issued a lengthy report upon the investigations it has made respecting the different systems of tramway traction in operation in various cities and towns in Great Britain, together with a number of important recommendations. The Committee has come to the conclusion that the overhead trolley system is the best, and, therefore, recommends its adoption, following upon the purchase of the present tramway company's undertaking. The scheme, which is outlined in the Committee's report, involves the reconstruction of the existing tramway lines and their extensions to various points on the outskirts of the borough. It also recommends that the direct current system should be adopted, with a central power station on land already belonging to the Corporation, in Belgrave Gate. If the scheme should be approved by the Town Council, Parliamentary powers will be sought for carrying out the various works involved, which will include the laying of 18 miles of double lines in the borough. The report will be brought before the Council for consideration at an early date.

Liverpool.—On Monday another new electric tram route was opened for traffic. This route connects Breck Road in the eastern district with Seaforth, north of Bootle, and at the extreme north of Liverpool, a distance of nearly four miles. The new route also establishes a connection between the business centre of the city at South Castle Street, and Seaforth *viâ* Breck Road and Breckfield Road North in the eastern district.

Mr. C. H. Bellamy, general manager, has presented to the Tramway Committee a return of the traffic, which showed that for the fortnight which ended on December 8th, there had been a decrease of £6,982 4s. 7d. in the receipts from horse cars and omnibuses compared with the same period of last year, while the electric car receipts had increased by £9,385 15s. 4½d. The horse cars had carried 1,201,177 fewer passengers, and the electric cars 2,043,481 more people. The decrease in the mileage of horse cars had been 162,027, and the increase of the electric car mileage 231,234 miles.

London Electric Railways and Property Owners.—Property owners affected by the projected electric railway under Bishopsgate met last week to consider their position. Alderman Sir Horatio Davies, M.P., presided. The *City Press* says that the tone of the speeches was not antagonistic to the proposed "tubes," but considerable stress was laid on the fact that the best way of protecting owners' interests was by the insertion of a clause extending from one to five years the period during which the railway companies were liable to compensate sufferers. For the purpose of furthering the object of the meeting a committee was formed.

New York Elevated.—In the *American Electrician* we read that the first official trial of an electrically-equipped train on the Manhattan Elevated Railway was held on November 22nd on the tracks of the Second Avenue line between Sixty-fifth and Ninety-third Streets. The test train made five trips between these two stations, and attained a speed of about 35 miles an hour. A private trial was made on the night of November 19th, on which occasion a speed of 40 miles an hour was attained. When the lines are finally equipped, it is thought that the running time on the Sixth Avenue line, between the Battery and 155th Street, will be reduced from 50 minutes, the present schedule, to about 40 minutes, or a trifle less, and express trains will make the run in about 25 minutes. Although the present schedule is 50 minutes, this is seldom attained during the morning and evening rush hours, the actual time being nearer 70 minutes. The greater acceleration ability of the electric trains, however, will undoubtedly reduce the running time very materially.

Roumania.—The municipality of Philippopoli, Roumania, is at present studying a project for the construction of a central power station for electrical traction and lighting. A start will first be made by the construction of four principal lines with a total length of 6·2 miles. A line will afterwards be constructed from Philippopoli to Stanimaka, 12 miles long. The motive power for working the station will be taken from a powerful torrent not far from Stanimaka.

Russia.—The municipality of Kertch, Yenikalae, Russia, is disposed to accord the concession of an electric tramway. The town, which has already a population of 50,000 inhabitants, is daily increasing in prosperity as a result of the establishment in the neighbourhood of different metallurgical factories and the exploitation of mines. A railway is at present in course of construction between Kertch and Theoosie. Further particulars can be had on application to the Azov-Don Bank, Kertch.

Spen Valley.—On 14th inst. the Spen Valley Light Railway and the Spen Valley Light Railway (Extensions) Orders came before the Board of Trade on objections raised to their confirmations by the Corporation of Batley and the Urban District Councils of Heckmondwike, Liversedge, and Gomersal, and the Great Northern Railway Company.

Stirling.—The Burgh Commissioners have resolved to serve notice on the Stirling and Bridge of Allan Tramways Company, Limited, requiring them to sell to the Commissioners that portion of the tramway undertaking which was within the boundaries of the burgh at the date of the passing of the above powers. The Commissioners are endeavouring at present to come to an agreement with the British Electric Traction Company and the Bridge of Allan Tramways Company for the disposal to them of their rights, and until the agreement is brought to a satisfactory termination, they have considered it wise to keep the other door open and maintain their rights in the matter.

TELEGRAPH AND TELEPHONE NOTES.

Portsmouth Telephones.—At a meeting of the T.C. last week, the Finance Committee reported that they had decided that the period for the license for telephones be 25 years, and that the maximum charge be £10 and the minimum £4. On the recommendation of the committee it was decided to advertise for a manager and engineer.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
African—St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
St. Louis (Senegal)-Teneriffe	Dec. 18, 1900	
South American—Pará-Maranham	March 1, 1900	
Pernambuco-Ceara	Nov. 29, 1900	
Cayenne-Pinheiro	Nov. 25, 1900	
Barcelona - Guanta - Cumana - Portlamar-Carupano (Venezuela)	Nov. 1, 1900	
Falmouth-Bilbao	Nov. 19, 1900	Dec. 18, 1900
Latakia-Cyprus	June 20, 1899	
Landlines:—		
African—Majunga-Tananarive	Nov. 6, 1900	
South American—Communications with all offices of Colombia beyond Buenaventura	January 29, 1900	
Interior of Colombia landlines	Nov. 19, 1900	
Ecuador landlines	March 3, 1897	
Landlines west of Barquisineto and Coro	Nov. 1, 1900	
Barcelona (Venezuela)-Ciudad (Bolivar)	Nov. 1, 1900	
Communication with Carthagena and Baranquilla	Dec. 8, 1900	
West Indian—Landlines to Barcoa, Guantago and Sagua de Tananamo	Nov. 12, 1900	
Landlines between Puerto Plata and San Domingo City	Nov. 20, 1900	
Chinese—Tientsin-Pekin	June 12, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *vîa* Shanghai	June 16, 1900	
Tientsin-Niuchwang	June 18, 1900	
All lines connecting Cochin China with Thuanan	Oct. 23, 1900	
Communication between Saigon and North Annam and Tonkin	Oct. 23, 1900	
Communication "*vîa* Hanekine" interrupted on Persian territory	Feb. 24, 1900	
Odessa-Kertsch	Dec. 12, 1900	Dec. 13, 1900

Telegraphic Communication between Liverpool and the Continent.—Lord Londonderry was waited upon on 14th inst. by a deputation from the Liverpool Chamber of Commerce and other bodies regarding the delay in telegraphic communication between Liverpool and the Continent, and the congestion of traffic

at St. Martin's-le-Grand. Mr. Charles McArthur, M.P., introduced the deputation. It was stated that cotton market reports were telegraphed twice a day to Havre and Bremen *vid* New York, as by that route they reached the Continent two hours earlier than *vid* London. Lord Londonderry said (according to the *Times*) that many complaints had been received since the deputation waited upon the Postmaster-General two years ago. Several parts of the memorial referred to faults in foreign countries, and these would have to be placed before the various foreign Governments. The granting of increased communication between Liverpool and other towns would depend very much upon the amount of work which could be promised in return for the extra wires. As there was a financial aspect the Treasury would have to be consulted.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—December 22nd. The E.L. Committee wants tenders for storage batteries. See "Official Notices" November 30th.

Asylum.—December 29th. The Committee of Visitors of the Winwick County Asylum, near Warrington, invites tenders for electric lighting, wiring, fittings, &c.

Battersea.—February 1st. Tenders are wanted for ordinary and prepayment electricity meters. Consulting engineers, Messrs. Kennedy & Jenkin.

Copenhagen.—January 3rd, 1901. The Corporation invites tenders for three 530-kw. dynamos, switchboards, &c. See "Official Notices" November 23rd.

Edinburgh.—December 31st. The Council wants tenders for the extension of the electric lighting installation at the City Chambers. See "Official Notices" to-day.

Exhibition Lighting.—Terms are required for lighting the March Trades, Inventions and Arts Exhibition of 1901. See advertisement pages to-day.

Farnworth.—January 10th. The U.D.C. wants tenders for the supply of eight 66-passenger tramcar bodies, motors, under-trucks, controllers, &c. See "Official Notices" to-day.

Harrogate.—December 25th. The Corporation wants tenders for two Lancashire boilers, with economiser and fittings. See "Official Notices" November 30th.

Hendon.—December 31st. The U.D.C. wants tenders for Lancashire boilers, stokers, pumps and economiser; two 150-kw. steam dynamos, motor transformer, &c.; condensing plant, crane, switchboard work, battery, mains, meters, and workshop equipment for electricity works. See "Official Notices" November 16th.

Leeds.—December 31st. The E.L. Committee invites tenders for two 1,400-kw. two-phase steam alternators and two sets of surface condensing plant. "*British manufacture.*" See "Official Notices" December 7th.

Manchester.—December 22nd. The Tramways Committee wants tenders for the supply of tramway bonds. See "Official Notices" December 14th.

Paraguay.—January 15th. The municipality of Asomption, Paraguay, is inviting tenders for the electric lighting of the town. Bond £600.

Partick.—The B.T.H. Company are to supply the Commissioners with a number of meters, fuses and demand indicators.

Partick.—January 7th. The Commissioners want tenders for steam dynamos, battery charging motor booster and balancer. See "Official Notices" December 14th.

Rathmines.—January 10th. The District Council wants tenders for Lancashire boiler, 300-kw. steam dynamo, condensing apparatus and pipework, switchboard extension, mains, and public lighting (incandescent). See "Official Notices" November 30th.

Sheffield.—January 21st. The Tramways Committee wants tenders for a slow speed vertical engine for driving a 1,000-kw. tramway generator. See "Official Notices" to-day.

Stavanger.—January 2nd. Tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by January 2nd, 1901. Further information may be obtained on application direct to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Swindon.—December 24th. The Corporation wants tenders for the supply of three high speed triple-expansion steam dynamos, balancer, and motor-generator for electricity works. See "Official Notices" November 30th.

Thetford.—January 1st. The Council wants tenders for wiring the new Town Hall.

Worthing.—December 31st. Tenders are wanted for a main switchboard. See "Official Notices" December 14th.

Worthing.—December 31st. The E.L. Committee invites offers from those firms willing to equip and maintain electric tramways. See "Official Notices" December 14th.

CLOSED.

Portsmouth.—The T.C. on Tuesday considered a report from the Tramways Committee submitting tenders for (1) The overhead line construction, which is to cover the present line, and also the extensions proposed to be made; (2) The permanent way and underground feeders, which will also cover the reconstruction of the present lines and the construction of the extensions proposed to be made. With regard to the first the Committee recommended the acceptance of the tender of Messrs. Macartney, McElroy & Co., at £18,280, and in that section tenders which were substantially in accordance with the specification were also received from the British Insulated Wire Company, Messrs. William Griffiths & Co., Messrs. Dick, Kerr & Co., Messrs. George Hill & Co., and Messrs. Lowdon Bros. & Co. A tender was also received from Messrs. R. W. Blackwell & Co. (London), but as it did not conform to the specification it was not dealt with. With regard to the second item, the Committee recommended the acceptance of the tender of Messrs. Dick, Kerr & Co., at £202,409 6s. 4d. As to this work tenders which were substantially in accordance with the specifications were also received from Messrs. William Griffiths & Co., and the British Insulated Wire Company. A tender was also received from Messrs. A. Krauss & Son (Bristol), but as it stipulated for various alterations in the specification, and as the committee could not accept the stipulations, the tender was not dealt with. Four tenders in connection with this part of the work were received for different portions of it, but as the committee had invited tenders for the whole of the work in one contract, these tenders were also not dealt with. In order that the Council might see the probable expenditure, excluding, of course, the amount to be paid to the tramway companies, and the expenses of the arbitration, the committee submitted the following estimate of the probable capital expenditure during the year 1901:—Contract No. 1 (cars and equipments), £48,562 11s. 6d.; No. 2 (power station plant), £29,656; No. 3 (power station buildings), £10,515; land for power station, £900; No. 4 (construction of permanent way and underground feeders), £202,409 6s. 4d.; No. 5 (overhead construction), £18,280; car sheds, land and buildings, special track and electrical work, say, £30,000; office expenses for reconstruction and extensions, Parliamentary plans, &c., which includes £3,783 expended under this head up to the present time, £7,000; total, £347,322 17s. 10d. Mr. H. Kimber moved the adoption of the report, and stated, in reply to inquiries, that there would be no difficulty about the contracts being completed within the specified 12 months. The resolution was carried.

Barnes.—The District Council has accepted the tender of the Schattner Meter Co. for electricity meters at £315. The erection of the buildings for the electricity works is not proceeding as speedily as the consulting engineer desires.

Bradford.—Messrs. T. Broadbent & Sons, Limited, are to supply a 30-ton electric travelling crane for the electricity works.

Burton-on-Trent.—The T.C. has accepted the tender of Messrs. Geipel & Lange, for the supply of a 400-kw. alternator, engine, and condensing plant, at a cost of £3,335. The increased demand has justified this extension. The Council has resolved to let out gas engines and electric motors.

Lowestoft.—The T.C. has accepted the following tenders:—Two boilers, pipework, &c., Messrs. Babcock & Wilcox, £2,069; 250-kw. dynamo coupled to Browett-Lindley engine, the Lancashire Dynamo and Motor Company, £2,200; storage tank, Messrs. J. W. Brooke & Co., Limited, £217 12s.; wiring Town Hall Messrs. Bush & Dryburgh, £180.

FORTHCOMING EVENTS.

Thursday, January 3rd.—At 8 p.m. Civil and Mechanical Engineers' Society. "The Case for Electric Power Distribution," by W. B. Esson, M.I.E.E.

Wednesday, January 9th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, 207, Bath Street.

Thursday, January 10th.—At 8 p.m. Institution of Electrical Engineers. Meeting at Society of Arts.

NOTES.

Institution of Electrical Engineers.—At the conclusion of the meeting of the Glasgow Local Section, Wednesday, December 12th, Prof. MacLean presiding, the following resolution, moved by Mr. H. A. Mavor, was carried with acclamation:—

That Col. R. F. Crompton and his gallant boys, who are being officially welcomed back from the front in London by our parent Institution on Tuesday next, be accorded a hearty vote of congratulation by this section, and that we send them our sympathetic wishes on the conclusion of their patriotic and arduous campaign.

The two meetings of the Glasgow Local Section that have already been held have been so well attended that the Committee have found it necessary to engage the large hall of the Institution of Engineers and Shipbuilders for their future meetings. It is fortunately disengaged for all except the January date, so after that meeting, which will have to be held in the small hall, the large hall will be utilised. At the first meeting in November, when Mr. Chamen read his paper, the small hall was so uncomfortably crowded that the Committee engaged the large hall for the important discussion on Mr. Langdon's paper. As a large number turned up, it is fortunate that this was done. Mr. R. F. Yorke will read his paper on "The Utilisation of Water-Power for Electrical Purposes" at the January meeting. The local hon. sec. tells us that the total membership of the Section now numbers 118, and that there are some 12 or 20 new candidates up for election. One point of considerable gratification to the Committee is the number of members of the Institution resident in other parts of Scotland whose business frequently brings them to Glasgow, and who appear to make a special point of so arranging that they are there for the meetings.

Damage by Fire.—Two serious fires in electrical works have been reported within the last fortnight—one the Brooklyn power house, the other Hooper's Cable Works. Moreover, at least three other disasters of the same nature have occurred in our cable manufactories during the past 12 months. We cannot understand why those responsible for the control of works so liable to damage by fire do not adopt some of the various modern automatic safeguards, such as sprinklers, which can be relied upon to confine the damage to its place of origin. No insurance affords real compensation for the loss sustained by the interruption of business caused by these regrettable occurrences.

The Royal Institution.—The arrangements for the Friday evening meetings before Easter, 1901, are as follows:

Friday, January 18th.—Prof. Dewar, M.A., LL.D., F.R.S., M.R.I., "Gases at the Beginning and End of the Century."
February 1st.—The Rt. Rev. Monsignor Gerald Molloy, D.D., D.Sc., "Electric Waves."
February 8th.—Prof. G. H. Bryan, Sc.D., F.R.S., "History and Progress of Aerial Locomotion."
February 15th.—Prof. J. J. Thomson, M.A., Sc.D., F.R.S., "The Existence of Bodies smaller than Atoms."
February 22nd.—Sir W. Roberts-Austen, K.C.B., D.C.L., F.R.S., M.R.I., "Metals as Fuel."
March 22nd.—Horace T. Brown, LL.D., F.R.S., M.R.I., "Some Recent Work on Diffusion."
March 29th.—The Rt. Hon. Lord Rayleigh, M.A., D.C.L., LL.D., Sc.D., F.R.S., M.R.I.

Supply Station Accidents.—In connection with the discussion which recent events have given rise to in our columns, Mr. F. B. Spencer, the electrical engineer to the Wimbledon Urban District Council, writes stating that some time ago, one of the men employed at the Wimbledon electricity works received a bad shock through careless handling of switchgear, and he was successful in bringing him round by the Sylvester method, as explained on the Electrical Review instruction sheet, which is now to be found on the walls of so many English electricity works. Mr. Spencer adds that had he not been on the premises, the result might have proved fatal, and he is now issuing clear notices and diagrams at each of his sub-stations and at the main station, so as to avoid any further accidents.

Personal.—We are informed that Mr. Slater Lewis, of Eccles, has retired from the position of engineer and general manager to Messrs. P. R. Jackson & Co., of Manchester, and has accepted a seat on the board of the Brush Electrical Engineering Company, Limited.

Mr. A. T. Smith, chief assistant engineer at Morecambe, has been appointed chief assistant electrical engineer at Bury.

We understand that Mr. D. C. McArthur Butler, of St. James's Hall, Piccadilly, W., has been appointed permanent secretary of the Municipal Electrical Association, and that all communications should in future be addressed to him.

At a meeting of the York Electric Lighting Committee on Monday, it was resolved to recommend the City Council to raise the salary of Mr. Midgley, the electrical engineer, from £200 to £300 per annum.

Mr. J. Douglas Allan has been appointed junior assistant for distribution at the Leith Corporation electricity works.

Lectures.—At the London Institution on 17th inst. Prof. Silvanus P. Thompson gave a lecture on the "Tercentenary of the Science of Electricity." This tercentenary he dated from 1600, because in that year appeared Gilbert's treatise *De Magnete*.

Mr. Hamilton Kilgour, borough electrical engineer of Cheltenham, delivered his presidential address to the Gloucestershire Engineering Society on 11th inst. He took electricity and electrical industry as the subject of his discourse.

A paper on "Electrically-Driven Hoisting Machinery" was read before the Ipswich Engineering Society last week by Mr. R. Stanley Lewis.

London Electric Trams.—The London County Council has decided to appoint an official competent to superintend generally the reconstruction for electrical traction of the whole of its tramways. The appointment is to be made as soon as possible, in order that he may make himself fully acquainted with the work to be carried out under the supervision of Dr. Kennedy. The salary is to be about £1,000 a year; and he is to be in the chief engineer's department, and to have a position analogous to that occupied by the mechanical engineer.

Transformer Litigation.—The Electric Lighting Committee reported to the Portsmouth T.C. last week in reference to the action by Mr. Rucker, that that gentleman had agreed to abandon his appeal on receipt of £750 towards his costs, and that the Defence Committee had agreed to make this payment.

At Mr. Duddell's Lecture.—If Prof. Ayrton, as reported in a contemporary, *did* liken the silent arc to the reed of a flageolet not blown, we would like to see that musical instrument. Hitherto we have been under the impression that the flageolet is reedless.

Manchester Electricity Works.—The Manchester City Council on Wednesday resolved to appoint Prof. Alex. Kennedy as electrical expert in connection with the electric lighting and tramway system. The fee to be paid is £15,000, payable by half-yearly instalments. Prof. Kennedy will find a resident engineer and an assistant for the time being.

Automobiles.—It would be a pity if the automobile industry were to be handicapped by the compulsory numbering of vehicles or further limitation of speed. Recklessness on the part of some drivers and owners has roused certain local authorities to agitate for some such regulations; the Automobile Club has therefore brought the seriousness of the matter before the local authorities of the kingdom, pointing out the possible evil effects of any such numbering, &c., at the same time issuing a warning to all motor drivers.

Stresses in Steam Engines.—When a year ago we pointed out some of the errors in the design of steam engines sent over to this country from America, we drew special attention to the common error of leaving the crankshaft to transmit the fly-wheel effects and the stresses due to short circuits. At the same time we pointed out the extravagant dimensions adopted for crankshafts in American engines of low speed type, and expressed a doubt whether the stresses due to electrical traction were so severe as those due to racing effects upon the shafts of screw propellers. Certain of our American critics waxed very wroth over us. Our criticisms were "amusing," and a good deal of temper was poured out upon us without any accompanying logic. We were told that English engineers could not know anything of shaft stresses with nothing but a little paltry marine experience to go upon. Marine stresses due to racing were nothing, while we had taken no thought of the unbalanced magnetic stresses due to the armature being too low. We were grieved to find how very carelessly American work was done to admit of such badly arranged magnetic stresses, as we could see no reason why they should be initially downwards, if not evenly distributed, nor could we see why provision should not be made for their adjustment. We thought it a pity at the time that a little plain criticism should be so badly endured, because, after all, English engineers have certainly had a longer experience of large shafts under trying circumstances than have any other engineers. A few weeks ago we learned that the American steamship *St. Paul* had completely wrecked one of her engines, and the only reason put forward for the mishap has been that the stern of the ship was thrown up by a heavy sea, the engines raced, and when the propeller came into the water again the shaft was twisted off, and the engines brought to utter smash. The accident is simply an illustration of the stresses that do occur to marine engines—stresses to which those of a traction plant with governors are a mere nothing. We do not suppose that the ss. *St. Paul* broke down through bad work, but because of a sudden stress, such as a year ago we stated to be not less than comparable with the short-circuit stresses on traction plant.

B.E.T. Athletic Club.—The athletic club attached to the B.E.T. Company recently held its second general meeting, Mr. J. Devonshire presiding. On Friday, the 14th, the club gave a very successful smoking concert at Anderton's Hotel. The concert was very well attended, and the organisers provided an excellent and varied programme.

Long-Distance Electric Transmission.—The *American Electrician* records that the Snoqualmie Falls Power Company, of Seattle, Wash., recently performed the notable feat of driving a motor 153 miles distant from the power house. All of the transmission lines of the company were connected up in series so as to obtain a maximum length of circuit. The test was made only for experimental purposes to demonstrate the practicability of power transmission over such long distances.

Lectures.—The first of a course of four lectures on electricity by Mr. T. C. Fulton, to be given under the auspices of the Glasgow and West of Scotland Engine Keepers' Association, was delivered at Glasgow on 12th inst., the subject being "Alternating Current Plant."

Smoke Prosecution.—The South London Electric Supply Corporation, Limited, were last week fined for smoke nuisance at Lambeth Police Court £10 upon each of 10 summonses, with 10 guineas costs on the first. The town clerk of Lambeth prosecuted.

Appointments Vacant.—A draughtsman is wanted for the Islington electricity works, and an assistant electrical engineer for the Hampstead station.

Large Order for Germany.—It was stated in our last issue that the contract for the supply of certain steam engines and dynamos of 25,000 H.P. capacity for the Charing Cross and City Electric Lighting Company had been placed with a German firm. We now learn that Messrs. W. Lahmeyer & Co., of Frankfort-on-Main, secured this contract.

NEW COMPANIES REGISTERED.

Railway Equipment and Construction Company, Limited (68,029).—This company was registered on December 1st, with a capital of £1,000,000 in £10 shares, to construct, acquire, equip, maintain and control, in the United Kingdom or any colony or dependency thereof, any railways, tramways, and other public works and conveniences, worked by steam, electricity, cable or other power, and to carry on the business of civil, electric and mechanical engineers, contractors, &c. The first subscribers are:—De L. H. Louderback, Hotel Cecil, W.C., railway manager, with 99,994 shares; H. H. Dalrymple-Hay, 20, Victoria Street, S.W., civil engineer, with one share; W. T. Potts, 8, Love Lane, Wood Street, E.C., traffic manager, with one share; J. Barlow, 14, Dorville Road, Ravenscourt Park, W., clerk, with one share; J. M. Caig, Aperfield Court, Biggin Hill, Sevenoaks, gentleman, with one share; S. Peck, Calbourne, Wallington, Surrey, clerk, with one share; and R. H. Howe, 16, Abbot's Park Road, Leyton, clerk, with one share. The number of directors is not to be less than three nor more than six; the subscribers are to appoint the first; remuneration as fixed by the company. Registered office, 9, Clements Lane, Lombard Street, E.C.

J. Player & Sons, Limited (68,081).—This company was registered on December 5th, with a capital of £1,500 in £1 shares, to acquire the business carried on at Coventry as "J. Player and Son," and to carry on the business of watch, clock, scientific instruments, electrical and cycle fittings, cyclometer and cycle accessory manufacturers and merchants, &c. The first subscribers (each with one share) are:—Mrs. E. N. Player, Allesley, near Coventry; J. W. Player, Coventry, watch manufacturer; Miss F. G. Player, Allesley, near Coventry; F. L. Heane, Wolston, near Coventry, farmer; L. Pacot, Hockley Hill, Birmingham, watchmaker; R. B. North, 14, Soho Square, W., watchmaker; and H. P. Jansen, 14, Soho Square, W., watchmaker. The number of directors is not to be less than two nor more than five; the first are Mrs. E. N. Player, J. W. Player, and P. B. North.

Northern Counties Traction Company, Limited (68,211).—This company was registered on December 12th, with a capital of £5,000 in £5 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for all purposes, &c. The first subscribers (each with one share) are:—G. E. Heyl-Dia, 236, Great Clowes Street, Higher Broughton, Manchester, mechanical engineer; J. J. Wilson, The Vicarage, Earlestown, Lancashire, accountant; W. J. Glover, 2, Clifton Terrace, St. Helens, cable manufacturer; H. S. Oppenheim, Highfield, St. Helens, solicitor; W. Oppenheim, Grange Mount, St. Helens, solicitor; J. Hammill, Millbrook, Eccleston, Prescot, chartered accountant; and H. Tasker, 46, Willis Street, Warrington, accountant. The number of directors is not to be less than two nor more than five; the first are to be appointed by Henry S. Oppenheim.

Electrical Navigation Protection Company, Limited (68,304).—This company was registered on December 15th, with a capital of £100,000 in £1 shares (95,000 "A" and 5,000 "B"), to enter into an agreement with L. Daft and A. Williams, and to carry on the business of electrical engineers, cable, wire, and line manufacturers, generators and distributors of electricity, electric light contractors, electricians, mechanical engineers, concessionnaires, explorers, contractors, &c. The first subscribers (each with one "A" share) are:—J. H. Milward, 350, Gillott Road, Birmingham, solicitor; C. F. Crowder, 2, Norfolk Row, Edgbaston, solicitor; A. T. Smallwood, Hampton-in-Arden, solicitor; W. J. Gilliver, 40, Blenheim Road, Moseley, accountant; J. W. Smith, Hill Crest, Woodlands Road, Moseley, accountant; E. Wyer, 270, St. Vincent Street, Birmingham, clerk; and T. Cooke, 7, The Grove, St. Silas Square, Lozells, Birmingham, clerk. The number of directors is not to be less than three nor more than ten; the first are to be appointed by the subscribers; qualification, £500; remuneration, £2,000 per annum and a share in the profits divisible.

Welsh Electric Traction Company, Limited (68,292).—This company was registered on December 14th, with a capital of £25,000 in £1 shares, to construct, equip and maintain railways, tramways, ferries, telegraphs, telephones, and other works and conveniences, and to carry on the business of engineers, manufacturers of railway and other carriages and vehicles, shipbuilders, carriers, electrical, mechanical, hydraulic, and general engineers, electricians, suppliers of electricity, &c. The first subscribers (each with one share) are:—C. J. Hall, Hawkesmoor, Windermere, gentleman; C. H. Lees, D.Sc., Osborne, Belgrave Road, Oldham, University lecturer; E. Hewitt, 33, Brazennose Street, Manchester, architect; W. G. Rhodes, M.Sc., M.I.E.E., Stansfield Terrace, High Bank,

Gorton; W. H. Robson, 53, Arbour Street, Southport, electrical engineer; T. Gould, 47, Manchester Road, Denton, hosiery manufacturer; and J. Morris, 33, Brazennose Street, Manchester, chartered accountant. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, £250; remuneration as fixed by the company. Registered office, 33, Brazennose Street, Manchester.

Cardwell, Boorman, Ford-Lloyd, Limited (68,268).—This company was registered on December 13th, with a capital of £5,000 in £1 shares, to take over the business of electrical engineers, manufacturers of electrical apparatus and appliances, &c., carried on by Cardwell & Boorman, at 27, Ely Place, Holborn, E.C., and by A. Ford-Lloyd & Co., at Boswell Court Works, Devonshire Street, W.C. The first subscribers (each with one share) are:—J. A. Cardwell, Melrose, Avondale Road, South Croydon, electrical engineer; E. H. Cardwell, 28, Soho Square, W., surveyor; A. Ford-Lloyd, Barnet Court Works, Devonshire Street, W.C., electrical engineer; A. R. O. Lowndes, 15, George Street, Mansion House, E.C., solicitor; C. Boorman, 27, Ely Place, Holborn, E.C., electrical engineer; E. A. Lowndes, 15, George Street, Mansion House, E.C., articled clerk; and J. H. Cardwell, St. Anne's Rectory, 28, Soho Square, W., Clerk in Holy Orders. The number of directors is not to be less than three nor more than seven. The first are J. A. Cardwell, G. Boorman and A. Ford-Lloyd (managing directors); remuneration of managing directors, £150 each per annum and a share in the profits; others as fixed by the company.

Fleet and District Electricity Company, Limited (68,293).—This company was registered on December 14th, with a capital of £5,000 in £1 shares, to acquire the right to supply electricity in Fleet, Hampshire, and the surrounding district, to adopt agreements (*a*) with H. Blacknell; (*b*) with F. J. Warden-Stevens; and (*c*) with W. Fennell, and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity for light, heat, motive power, and other purposes, &c. The first subscribers (each with one share) are:—W. W. Norman, Essendene, Chobham Road, Woking, secretary; F. J. Warden-Stevens, The Mount, Leatherhead, engineer; F. P. West, 5-6, Great Winchester Street, E.C., chartered accountant; W. Fennell, 8, Ferndale Road, Leytonstone, electrical engineer; C. J. Inder, 5, Albion Square, Dalston, N., electrical engineer; S. Hutchison, 47, Chancery Lane, W.C., solicitor; and T. J. Woods, 15, Wylen Street, Forest Hill, S.E., clerk. The first directors are Sir T. L. Brunton, H. Fraser, and F. J. Warden-Stevens. Registered office, 5-6, Great Winchester Street, E.C.

Easton & Co., Limited (68,181).—This company was registered on December 10th, with a capital of £100,025 in 30,000 preference shares of £1 each, 70,000 ordinary shares of £1 each, and 500 subscribers' shares of 1s. each, to acquire and exercise the sole license for Great Britain, the British Colonies, and the Transvaal to manufacture and sell stationary engines of over 10 H.P. and apparatus in connection therewith under the Schmidt Superheated Steam Patents (subject to a non-exclusive license already in favour of Sulzer Bros., of Zurich, and the Aschersleben Maschinenbau Aktiengesellschaft), and to take over all or part of the business of electrical, mechanical, civil and general engineers and contractors, recently carried on by Easton, Anderson and Goolden, Limited (in liquidation), and by W. B. Peat, the receiver and manager thereof, at Erith, Kent, and at Broad Sanctuary Chambers, Westminster. The first subscribers (each with one ordinary share) are:—O. G. Petersen, 82, Wood Vale, Forest Hill, S.E., solicitor; F. J. Stephenson, 21, Kensington Gardens Square, W., clerk; G. C. Gooding, 7, Porteus Road, St. Mary's Terrace, W.; A. S. Wilson, The Hollies, Rustall, Tunbridge Wells, Kent, clerk; C. H. Perry, 5, Springfield Gardens, Upper Clapton, N.E., clerk; E. Turkington, 11, Dovecote Avenue, Wood Green, N., clerk; E. T. Ironside, 75, Loftus Road, Shepherd's Bush, W., clerk. The committee of management is to consist of not less than three nor more than seven members. The first are E. L. Pease, G. B. Samuelson, H. K. Baynes, T. P. Wilson and three others—two to be nominated by the debenture holders, and one by H. A. Johnstone. G. B. Samuelson is the nominee of the Schmidt Stationary Engine Company, Limited. Registered office, Broad Sanctuary Chambers, S.W.

CITY NOTES.

Nernst Electric Light Company, Limited.

The first ordinary general meeting of the shareholders of this company was held on Wednesday at the Westminster Palace Hotel, Sir Henry C. Mance presiding.

Mr. G. Opitz, the secretary, having read the advertisement convening the meeting,

Mr. Benn Zusman, one of the directors, requested that a notice he had sent to the shareholders containing three special resolutions he intended to move at the meeting should also be read. These resolutions required the directors to invite Mr. B. M. Drake, the managing director to resign his position, and in the event of his not consenting, to call a special meeting to remove him from office. A further resolution called upon the directors to allow Mr. Zusman to have unrestricted access at all reasonable times to the books, papers, and documents of the company.

The Chairman, in moving the adoption of the report, said he was sure the shareholders would be pleased to see Prof. Nernst once more amongst them, and he might take the opportunity of expressing their congratulation of his having been awarded the Grand Prix at the Paris Exhibition on account of his beautiful invention. Dealing first with the balance-sheet, some of the items on the credit side might appear large, but it was in consequence of the accounts covering a period of 19 months. The payment of £1,523 on account of legal charges and stamp duties was almost entirely for the latter, which amounted to £1,350, which payment was made under the advice of counsel. The item of £5,000 on account of English royalties would, he trusted, ultimately prove a very satisfactory investment. The directors were not without hope that their right to those royalties might enable them to come to some satisfactory and mutually advantageous arrangement when the English company was brought before the public. The expenditure on the laboratory and workshops had, he thought, considering the importance of the work which had been carried out, been moderate. £20,311 had been invested—half in Bank of England stock and the other half in Consols. Passing to the general business, he would remind those shareholders who were not present at the statutory meeting that on that occasion Mr. Swinburne, their consulting engineer, advised them not to be precipitate in putting the lamp on the market and he predicted that the autumn of this year would be about the time when they would be prepared to issue the lamps to the public. The invention was handed to them in what he might call a laboratory stage. It was practically untried; they had to deal with a new industry, and with the exception of the technical staff provided for them by the promoters, they were absolutely ignorant of the difficulties which might occur in developing the invention into a commercial success. Before they could shape out their future policy they had to produce a commercial article. A commercial article was one that must be manufactured with economy, and if any of them would take the trouble to visit their laboratory and works, and see all the delicate apportionment which was necessary between the parts of the Nernst lamp, they would appreciate the difficulty they had had in training the necessary staff before they could manufacture in large numbers. He did not make these remarks by way of apology. If he wanted any excuse as regarded the delay in placing the lamps on the market, he would draw their attention to the fact that, notwithstanding that they were at a great disadvantage as compared with the owners of patent rights in other parts of the world, they were quite as much advanced. He believed he was correct in stating that Mr. Westinghouse, the General Electric Company, of Berlin, and Messrs. Ganz & Co., of Buda-Pesth, had the control of the patents 12 months before they had, and he very much doubted if at the present moment they were any further advanced. Indeed, he had just received a telegram from Messrs. Ganz, saying they would not be prepared to issue lamps before April or May next. While they had been working towards the development of lamps which could be manufactured with certainty and economy, they had steadily pursued their inquiries in all parts of the world within their sphere of action with a view to ascertain the extent of electric lighting and the conditions which it would be necessary to observe in sending lamps to that particular locality. It might interest them to know that the extent of lighting in the various countries appeared from the reports to be that there were 38,000 arc lamps and 5,000,000 incandescent lamps in use in their various territories. They had obtained 47 patents in various parts of the world, and their applications for 14 other patents were still pending. They now had as their property a lamp which, he hoped, would prove a second Aladdin's lamp, but he could assure them that, unlike the lamp of Aladdin, it had required something more than rubbing before arriving at its present stage. He could not leave that point without endeavouring to do justice to the attention and care which had been bestowed by Mr. Drake in supervising the elaboration of the various details, and he deeply regretted that one of his colleagues should have considered it necessary, when their labours had reached that point at which they might look forward to obtaining some practical results, to make an attack upon the managing director. He considered the attack unnecessary, inopportune, and unjust. Had they done nothing beyond acquiring the English royalties, the total expenditure which had been incurred would have been perfectly justified. By not establishing factories before they were actually required, and not sending out agents prematurely to advertise an invention which spoke for itself, they had saved the company a considerable sum. They now possessed a very valuable property, and it rested with that meeting whether they intended to do it serious harm.

Mr. Bernard Drake, in seconding the resolution, gave a short *résumé* of what had been done by the company since its inception to perfect the lamp. They had, he said, now taken the plunge as far as the body of the lamps was concerned, and the replacement pieces which carried the glower, heater, and series resistance, could be modified from time to time as experience dictated. They had some hundreds of lamps of different sizes and candle-powers, which could be sent out in the course of the next few weeks. Within two months they were arranging for a supply of the different parts to be coming in, and within three months, unless something unforeseen happened, he expected their output to be several hundred lamps per day. He thought, therefore, the company might be congratulated on being within sight of the money-earning stage.

Mr. Benn Zusman then addressed the meeting at considerable length in a speech in which he criticised adversely the action of Mr. Drake in several particulars in the management of the company. He said that, in his opinion, the past conduct of the undertaking by Mr. Drake had been opposed to its true interest, and that its future was foredoomed to failure if he was permitted to maintain any longer the position of managing director, or if he was allowed to remain a director at all. If the present policy of inanition

continued, it could only end in liquidation. He concluded by moving as an amendment to the Chairman's resolution that the report be received, but not adopted.

Mr. A. Cohn seconded the amendment.

Mr. R. C. Power said he thought the shareholders were indebted to Mr. Zussman for his action at the board, and he hoped the meeting would refuse to adopt the report without further investigation.

Mr. Mitchell and other shareholders having addressed the meeting,

The Chairman and Mr Drake replied on the discussion, Mr. Drake giving a most emphatic denial to any suggestion of neglect of the company's business, remarking that he had done nothing in connection with the company that he would not have done had the company been entirely his own.

After further discussion the meeting was adjourned for a month on the understanding that copies of Mr. Zussman's charges and Mr. Drake's replies should in the meantime be circulated among the shareholders.

Marconi's Wireless Telegraph Company.

The fourth ordinary general meeting of this company was held on Tuesday at the offices, 18, Finch Lane, E.C., Major Flood Page (managing director) presiding.

In moving the adoption of the report, the Chairman said that the accounts were for 13 months, as the financial year had been changed from August 31st to September 30th. There had been practically no change in the capital. The stock, which last year was £4,515, had increased to £9,111, and plant and machinery had increased from £300 to £1,692. Patents stood at £78,164, £1,153 higher than last year. He was pleased to inform them that, after much prolonged negotiation, they had this month obtained the German patents, and everyone knew how important that was. Their German patent agent also said that then several other applications stood a very good chance of being granted. The chairman said that he had been called to give evidence before the British Patents Committee sitting at the Board of Trade, and he thought he was not divulging secrets when he said that the Committee had no intention of introducing into England either the United States or German patent systems. The shares of the International Company, of which this company held 100,000 fully paid, were at a promising figure in the market, although there were very few transactions in them (5s. paid were selling at 7s. 6d. and 8s.) He thought in the future they would have to be congratulated upon the value of their 100,000 shares. The balance-sheet showed the expenditure up to August 31st £10,960. They had then a stock of £4,236. Purchases and wages had amounted to £10,854. As the business extended the purchases and wages must extend also. They were glad it was so, as it was proof that they were beginning to live. Salaries and directors' remuneration figured at £5,926. This item and also travelling expenses, &c., might appear high for so small a business, but they had about 24 more or less technical electrical men as assistants. During the present year some had been and still were at Hawaii, Germany, Newfoundland, Malta, Spain, and other countries, while a large number of them were employed in work in the Navy. As the work still further increased probably they would not have to largely increase that class of men but others less expensive. Sales and royalties (£6,092) was a very small amount, but it was the first time it had appeared in the balance-sheet. The total expenditure was, in his opinion, most moderate, and had been absolutely necessary. The Belgian Government had been a good friend to them, and this would be of material assistance to them in influencing other powers. There were great difficulties in negotiating with foreign Governments. The action of the cable companies in closing the cables during the war created a very great objection to the British monopoly of telegraphic work. Negotiations were, however, being conducted by their Continental friends in the respective countries. The chief event of the year was the completion of the whole of the 32 sets for H.M. Navy. They had had no failure or breakdown of any kind. As the commercial shipping companies followed the Navy in electric lighting of vessels, so no doubt they would follow in this matter of wireless telegraphy equipments. The works at Chelmsford had been improved, and could now turn out all the apparatus that could possibly be required during the coming 12 months. Mr. Marconi had made great advances recently. He asked them not to request him to say much about that matter that day. They must do without exaggeration. Mr. Marconi had never proclaimed in public that he could do a thing until he was assured that he was able to do it. What they had now accomplished could not be seen by the Admiralty or anyone else until it was complete; it gave promise of great advance. By the end of January they might be able to show the Admiralty what the new patents involved, the improvements they compassed, and they had a provisional contract with the Admiralty as to their use in the event of their thinking fit to adopt them.

Mr. Goodbody seconded the resolution, which was carried unanimously.

The retiring directors and auditors were re-elected, and the meeting then became extraordinary, to pass resolutions altering the articles so that the qualification of directors was reduced, the number of directors and their fees increased, and other matters altered to meet certain specific cases. It was mentioned that three new directors are to be asked to join the board to strengthen it, so that future negotiations with Governments and others might be certain of success. These were Mr. Henniker Heaton, Sir Chas. Euan Smith, and Mr. Albert Ochs.

The meeting closed with the usual vote of thanks.

Aron Electricity Meter, Limited.

Sir James Pender, Bart. (chairman), presided on Thursday last week at Winchester House over the third ordinary general meeting of the above company.

In moving the adoption of the report, the Chairman said were it not for the traditional chairman's speech at such a meeting, he would have little to say, but would simply ask them to pass the report and call for any further information if they so desired. They had had a most successful year, in spite of the many difficulties that a business with branches in the different capitals of Europe had to contend with, and in spite of the difficulties that arose in the wholesale manufacture of accurate measuring instruments. Thanks to the efforts of Dr. Aron and his technical staff, they had overcome these latter difficulties, and thanks to their commercial department, they had been able to show a good increase of business. The sales of the instruments had gone up for this year by 40 per cent. as compared with last year, and the profits, which, in their prospectus, showed a course of uninterrupted progress from £11,000 in 1892 to £18,000 in 1897, had now reached in the last two years £23,000 and £30,000 respectively. The increase in trade had been noticeable in every one of the branches, but more particularly in England, though the profit in the United Kingdom this year did not show as favourably in proportion to the turnover as in the other countries. The reason for this was that they had arranged, both in Thames Street and in Union Street, Southwark, larger workshops, which would enable them in future to manufacture entirely in England with the exception of the counting gears, which were manufactured for all the branches in the central factory in Schweidnitz. Thus the promise of making the meter in this country had been fulfilled very quickly, and now that the expenses of erection and organisation had been principally defrayed, they could look hopefully to a very much larger percentage of profit from the London business in the future. This was irrespective of the increase in sales, that they had every right to expect. The orders for meters during the last two months since the end of the financial year, namely, October and November, exceeded in England by 40 per cent. the sales of the corresponding months of last year, and in the other branches an increase had also been made. Every one of the branches during the last year had worked at a profit, the most satisfactory result being that the factory in Schweidnitz, which was in an embryo state last year, showing even a small loss at that time, had shown this year a very handsome profit after paying all expenses, and the directors had made arrangements for considerably increasing this factory, which should be the most remunerative department when the prices of raw material had again assumed a more normal aspect. The sale of the American patents was now so far effected that all but £4,000 in cash had been paid, and the stock to the face value of £33,000 had been handed to them and deposited with the bankers. By utilising the sum of £9,400 for writing off part of the original purchase money and putting the whole of the American stock, which a few years hence would be very valuable, towards reserve, the directors thought ample provision has been made for satisfying the best interests of the shareholders and the company. Dr. Aron, during the past year, had succeeded in introducing further important improvements to suit the requirements of the station engineers, which consisted in the change over from wood to metal cases, in simplifying the design and manufacture of the meters, in the introduction of meters for special purposes, such as day and night load meters, hour meters, automatic prepayment meters, and they looked forward to a considerable increase of business from those developments. Another distinct improvement had been the design of a small meter which they called the "Cottage" type, now in the hands of the Board of Trade for official approval. This was a meter that could be made and sold at a considerably lower price, and will be used in small houses and shops in the poorer districts in town and country where the electric light was now making its advent, where only two or three lights were probably burning at a time, and where a small and accurate, but particularly a cheap meter was a necessity. It was unwise to predict unless they knew, but they believe that this meter, as constructed at present, would meet completely the most stringent regulations of Government and municipal authorities, and be a large additional source of revenue in the future.

Mr. R. W. Wallace, Q.C., seconded the motion.

In answer to questions raised, it was stated that there was no truth in the rumours as to probable litigation regarding patents. When stock was taken, from 15 to 20 per cent. was written off for depreciation.

The report was adopted, as was also a resolution for the payment of a dividend of 12 per cent. on the ordinary shares.

India-Rubber, Gutta-Percha, and Telegraph Works, Limited.

The Hon. Henry Marsham (chairman) presided at the Cannon Street Hotel on Thursday last week over the 37th ordinary general meeting of the shareholders of the above company, and in moving the adoption of the report, said they would not have come forward that day with such a favourable balance-sheet had it not been that they took the unpopular step of raising the prices of their goods to meet the advance in the price of raw material. Their customers tacitly acknowledged the necessity of so doing by continuing their support. They intended returning to more moderate prices at the earliest opportunity, and from the appearance of the markets it was possible they might be able to make reductions before they again met. India-rubber showed signs of falling off, but gutta-percha main-

tained its high standard, and in view of the large consumption in the next year or two, they did not anticipate a lower price in that product. They had three cable steamers, and all were at present employed, one having been chartered by the Spanish Government since the end of the financial year. At the works at Silvertown they had completed a large central station for the generation of electricity. All the machinery had been designed and built by their own employés. The construction and erection of the plant under these circumstances occupied a longer time and cost more than they otherwise would because they did not want to interfere with the carrying out of work for their customers. By the erection of the station a great saving in coal would be effected. With a view to increasing their business they had sent a representative to South Africa, and although, as was only to be expected, not much had yet been done, yet when matters settled down they expected to do a large business there. They had received no official reply to their tender for the Pacific cable, but from the figures which had been published in the Press of the price, viz., £1,795,000, they could only judge that the board had been too timid in approaching the subject, but they felt that with a work of such magnitude they could not be too careful, and although they had missed the contract he trusted the shareholders would approve of their policy. With regard to future prospects, they had now in hand a large order for a foreign Government. They recommended the payment of a dividend of 15s. a share, making with the interim dividend 10 per cent. for the year.

Mr. A. Scott seconded the motion, which was carried.

Mr. Lamont questioned the chairman as to the auditors' certificate, which he said appeared to imply some doubt as to the correctness of their investments and the debts owing to them.

The Chairman said he saw no reason why the auditors should question the correctness of the items. The debts included money owing on uncompleted work, which had since been paid. The board took the full responsibility as to the investments, which were worth what was stated to be their value.

At the extraordinary meeting which followed, special resolutions were adopted, giving the board power from time to time to appoint extraordinary directors, or an extraordinary director, additional to the directors, and not to be considered to be directors of the company within the meaning of the articles of association, and the board might from time to time revoke any such appointment. The number of extraordinary directors should not exceed four, and no person other than a former director, or an officer of the company, should be appointed an extraordinary director. Every extraordinary director (not having been formerly a director) who should cease to be in the employment of the company, should thereupon cease to be an extraordinary director. Every extraordinary director should hold at least 100 shares of the company in his own name as the sole holder thereof. No person should be appointed an extraordinary director for a longer period than three years at any one time, but the appointment might from time to time be renewed. The remuneration of an extraordinary director, for acting as such, shall from time to time be determined by the board, and should not exceed £200 per annum for any extraordinary director.

Electric Resistance and Heating Company.

The first ordinary general meeting of this company was held at Winchester House, E.C., on Tuesday, December 18th, Mr. C. Wanklyn, presiding. The report submitted reads as follows:—

The directors herewith submit their first annual report, together with the company's balance-sheet and profit and loss account from January 1st, 1899, to September 30th, 1900. The primary or material patent of the company has now been granted in all the countries enumerated in the prospectus, with the exception of Germany, Denmark, Norway and Russia. In Russia an application is still pending. In the other countries mentioned, reliance is placed on secondary apparatus patents, which have been granted. Material and apparatus patents have also been taken out in Cuba, a country not mentioned in the prospectus. The board has devoted unremitting care and attention to the development of the company's manufactures, but, as is generally the case with a new process, progress has been slower than was anticipated, and the adaptation of the material to the various requirements has presented many difficulties. In the opinion of the directors, however, most of these difficulties have now been overcome. The work of the company is now so far advanced that types of completed manufactures have been under trial for some weeks at the company's works, and since the end of last month at Messrs. Veritys, Limited. Some of these are now on view at Messrs. Veritys' showrooms, 31, King Street, Covent Garden, W.C. The directors are satisfied with the result of these trials, and it is believed that the manufactures of the company will show good results in practice. The demand for the class of goods to be supplied by the company should certainly be very large. The directors have had under consideration proposals recently made by Messrs. Ganz & Co., of Buda-Pesth, for supplying the company, at fixed prices, with its resistance and heating material in a manufactured state, and in such types as may be required by the company. No definite arrangement has yet been come to in reference to this matter, but, under existing circumstances, the acceptance of these proposals, wholly or in part, might be of advantage to the company. Under circumstances of which the shareholders are already aware, the company failed to receive payment in full in respect of 8,550 shares relied on as part of the working capital, and owing to the great importance of completing types of resistances of various kinds and other manufactures for the market before the end of the present year, the funds at the company's disposal are approaching exhaustion. It has, therefore, become necessary that the 8,550 forfeited shares referred to in the board's circular of June 18th last on which 5s. has been paid, should be subscribed for at 15s. each. These shares will be offered to all shareholders for subscription before the 12th proximo, without any restriction as to the number which may be applied for in each case, and in the event of more than the 8,550 shares being so applied for, allotments will be made *pro rata*, except that, in the event of the negotiations referred to in the note to the balance-sheet by the auditors being wholly or partially carried through, the allotment of the 8,550 shares will be restricted to the number of these shares available. Mr. C. Wanklyn and Lieut.-Col. W. T. Ellis are the directors retiring from the board by rotation, and being eligible, they offer themselves for re-election. Messrs. John Annan, Dexter & Co., the auditors, also retire, and offer themselves for re-election.

The Chairman said that though there were certain elements of disappointment, he hoped to show them that there was still some hope that their process had a future before it. They had been unable to obtain the material patent in Germany, but had obtained a large number of apparatus patents—in fact, all applied for but one, and in those apparatus patents the patent agents said that the material patent was alluded to in such a way as to protect them under that head also. As to the development of the company's manufactures, it was impossible for him to adequately put before them the enormous trouble, constant anxiety and work that had been entailed in the progress of the endeavour to prove the value of the process. One by one in the course of the manufacture difficulties had arisen, and as each had arisen it had been met, but they had always naturally to go back again to the beginning. That was the main difficulty in the whole business. They had no experience to guide them as to what they ought to have foreseen, but at every turn they had had to meet something new for which a remedy had to be found. While they could not be absolutely exonerated in respect of any difficulties that had arisen, it was absolutely out of human understanding and experience that they should be able to foresee those difficulties and meet them before they arose. At the works at Lambeth they had produced a number of types of different forms of resistance such as were now on view. The larger ring resistances had given them a great deal of trouble, for the fact that it had been extremely difficult to press them with such compactness that they could stand the handling of commercial use. Half-sized rings had been working well at the company's works for many months. Certain rings had been working lately at Veritys with equal satisfaction, but he was bound to add that recently certain of them were put to special tests—maximum tests at Veritys, to prove whether they were of the capacity hoped for, but there, again, certain defects became obvious to everybody. Overheating resulted in the disintegration of the ring itself, and small marks showed, which, under maximum pulling tests, would have meant inefficiency of the ring. They would be able to overcome the difficulties in time. Testing was still going on, and in a few weeks they hoped to be able to announce the end of their troubles. They were again applying for the subscription of the forfeited shares, and in the event of a material development taking place, they would communicate with the shareholders immediately. In regard to the failure in the subscription of the large amount of working capital, they made an issue of 8,550 shares, and the subscriptions only came to 2,400, and of those 1,800 were applied for by the board, but there was no good to be done by allotting that small amount, and they returned the subscriptions and went on with what was in hand. The failure to find 15s. on 8,500 shares was a knock-down blow for the board. The accounts showed how serious and critical the incident was. The prospectus stated that they were to go to work on £17,500 working capital. Taking patent charges and fees, agreements, legal expenses, and plant and furniture, they might say that of the working capital £5,500 was already spent before they began to exploit the process. Another third had been spent, and £6,550 had never come into the coffers. This £6,500 was the most important of all. They were stranded at a position where the process might be made a great success, and the working capital was not available. After the meeting they would send out forms to shareholders for those 8,500 shares. If that money was not received there was only one course open to them, and that was liquidation for reconstruction. They had already got in outline proposals for reconstruction which would include the guarantee of a certain amount of new working capital, and would start where they now left off. The vendors took part of their consideration in 62,000 shares, and it might be hard to put the pistol of reconstruction at their heads, but any regret that they might feel at the cancellation of any portion of the vendors' shares might be qualified by the fact that when the shares were issued in general, the support received from them amounted to nothing. In giving them this second chance in common with other shareholders they would have done enough, and liquidation with reconstruction in view was the only policy. There was no question about the enormous demand and sale of any types of the material in the manufacturing state.

Captain Bax seconded the adoption of the report.

A Shareholder asked what the vendors took in cash, and was informed £32,500. Another speaker said that if they had had that sum he did not think they need show them any particular consideration.

The retiring directors and auditors were re-elected.

Prospectuses.

In our other pages this week will be found a copy of the prospectus of the British and Foreign Electrical Vehicle Company, Limited, which has been formed with a nominal capital of £150,000. Only 54,000 £1 shares are being offered for subscription, the vendors taking the remaining 96,000 in part payment of the purchase consideration. The objects of the company being fully stated in the prospectus, it is not necessary to enter into detail here. The principal things taken over are the Leecoll Electric Battery Company, Limited (which owns the British patents), and a half share in the foreign patents. We have no wish to unsay any of our remarks regarding the excellent performances of the "Powerful" electromobile, and the Leecoll battery in our article on the recent electrical vehicle trials made under the auspices of the Automobile Club, but we regard the amount to be paid to the vendors as excessive, when it is considered that the battery is a new one, and has not yet been practically tried for any length of time. We stated that this type of cell *may have* a great future before it for traction and other purposes; but its present performances do not appear to us to warrant the payment of £106,000 (£10,000 in cash, and £96,000 in shares) to vendors for patent rights, and the Lambeth and other

depôts and charging stations, or leases thereof. There have been too many instances recently of companies being absolutely crippled by the high value which vendors have placed upon patents, and while we are hopeful of a good future for this particular battery, we regret to find it saddled with so heavy a share capital due to the promotion process. The paying of a reasonable dividend is considerably imperilled on this account. It is an error in company finance which not only tells upon the general body of shareholders by reducing dividends, but it may render valueless the large shareholding of the vendors themselves unless they are able to unload before the evil days draw nigh. Many a new company has defeated its own ends by over-capitalisation, and has been unable to proceed to allotment because of the chariness of investors. The company appears to be primarily a battery company, but it has an optional contract relating to the supply of carriages manufactured or imported by E. W. Hart, of Luton.

The Woking Electric Supply Company has this week been offering an issue of 25,000 6 per cent. £1 preference shares, to provide for outlays already incurred in the laying of new mains, and the purchase of two 150-kw. alternators, also to provide additional working capital.

Easton & Co., Limited.—We learn that a powerful syndicate has been formed under the title of Easton & Co., Limited, to take over the extensive and old-established engineering works of Easton, Anderson & Goolden, Limited, at Erith, with a view to the development in this country of the Schmidt system of utilising highly superheated steam, which has made such remarkable progress abroad. No public issue will be made, the necessary capital having been subscribed privately by a group of leading engineering firms and others.

Ingleton Electric Lighting and Power Company.—This small company held its first annual meeting on 6th inst. The plant is all in working order, and about 60 houses are connected to the mains. The company also has the contract for the public lighting. There was no dividend, as the company had not been long in operation, but there was every prospect of the business becoming remunerative shortly.

Continental Companies.—The Mediterranean Thomson-Houston Company, which was constructed in 1898 with a capital of £200,000, has increased its capital to £800,000. The chairman and vice-chairman of the company are respectively M. Fris (Senator) and M. Th. D. Lantsheere (Minister of State).

Dividends.—Eastern Extension Telegraph Company, quarter ended September 30th, 2s. 6d. per share. Electric and General Investment Company, six months ended November 30th, 10 per cent. (2s.) on the ordinary shares.

National Telephone Company.—The transfer books of the 3½ per cent. and 4 per cent. debenture stocks will be closed from the 18th to the 31st inst. inclusive, for the preparation of the warrants for the half-year's interest due January 1st.

South Lancashire Electric Traction Company.—The final batch of letters of allotment and regret have been posted in regard to applications for debenture stock and preference shares in the South Lancashire Electric Traction and Power Company, Limited.

Chelsea Electricity Supply Company.—The transfer books of the debenture stock are closed from 19th to 31st inst.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending December 15th were £146; corresponding period last year, £96; increase, £50. Total to date, £19,999; corresponding period last year, £19,961; increase, £38.

Bristol Tramways and Carriage Company.—The receipts for the week ending December 14th were £3,579 3s. 11d.; corresponding period last year, £2,341 11s. 9d.; increase, £1,237 12s. 2d.

Central London Railway.—The receipts for the week ending December 15th were £6,006; previous week, £5,740; increase, £266. Total receipts to date (20 weeks), £105,433. Miles open, 6.

City and South London Railway.—The receipts for the week ending December 16th were £1,874; corresponding week last year, £1,151; increase, £723. Total to date, £39,649; corresponding period last year, £23,822; increase, £15,827. Miles open, 1900, 4½; 1899, 3½.

Cork Electric Tramways and Lighting Company.—The receipts for the week ending December 13th were £372 11s. 0d.; corresponding week last year, £302 5s. 6d.; increase, £70 5s. 6d. Total to date, £20,868 0s. 7d.; corresponding period last year, £18,977 19s. 3d.; increase, £1,490 1s. 4d.

Dover Corporation Tramways.—The receipts for the week ending December 15th were £163 9s. 5½d.; corresponding week last year, £126 17s. 2d.; increase, £36 12s. 3½d. Total to date, £10,250 19s. 1½d.; corresponding period last year, £9,734 17s. 9d.; increase, £516 1s. 4½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 4,958; 1899, 4,788. Number of cars 1900, 11; 1899, 11.

Dublin United Tramways Company.—The receipts for the week ending December 14th were as follows:—D. U. T. Co., electric cars, £3,855 16s. 2d.; ditto, horse cars, £21 8s. 0d.; D. S. D. Co., electric cars, £794 2s. 6d.; total, £4,171 6s. 8d; corresponding week last year—D. U. T. Co., electric cars, £2,729 10s. 6d.; ditto, horse cars, £102 15s. 7d.; D. S. D. Co., electric cars, £594 3s. 11d.; total, £3,426 8s. 0d.; increase, £744 18s. 8d.; aggregate to date, £111,228 10s. 9d.; aggregate to date last year, £99,402 12s. 7d.; increase, £11,825 18s. 2d. The mileage worked is 44 miles electrically, 1 mile by horses, as against 37 miles electrically, 7 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending December 16th were £1,527; corresponding week last year, £1,432; increase, £95. Total from July 1st, 1900, £39,658; ditto corresponding period last year, £38,908; increase, £750. Miles open, 6·57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The shadow of Christmas holidays is falling over the Stock Exchange markets, but still the volume of general business is fairly well maintained. It has eased off to some extent in the electrical sections, but this is not surprising, as they are, of course, investment markets, and it is the speculative departments that are now attracting most attention. The revival of the boom in Yankee rails has benefitted the Anglo-American Telegraph Company's stocks, which have at last thrown off the weakness that for so long has bowed them down. The supply market is a trifle irregular in tone, but the fluctuations are neither many nor important. As regards the Electric Railway division, there has been a slight improvement in the Deferred halves of Central London shares.

We are able to announce that the directors of the Brompton and Kensington Supply Company are now considering a scheme for obtaining more capital. The money is required for the purpose of paying off the existing Debentures, and making alterations and additions to machinery, and soon, we understand, a new issue of Ordinary and Preference shares will probably be made, at such prices as will give the proprietors of existing shares a bonus besides swelling the coffers of the company. Brompton Ordinary shares, of £5 each fully paid, stand at 7½, and the Preference, which are of the same denomination, are £9 middle.

The recent emission of Preference shares by the Edmundson's Company has been well received, and the quotation in the market keeps up at ⅞ premium, over and above the issue price of £5 5s. It is rather remarkable that the Ordinary shares of this concern should be purchaseable below par. The company paid 6 per cent. last July; its capital is small, even counting the new Preference issue, and the only reason we can see for the lowness of the price is that investors overlook the shares on account of there being so few. They do not seem dear by any means, and can be bought for 4⅜ or a shade more.

All the Charing Cross Preference shares are now on the same footing, and the price is 5⅝; Chelsea new Ordinary are 5s. premium.

Should there be any one of our readers who applied for British Electric Street Tramways shares before reading our article thereupon, and who has received an allotment of shares which he does not want, we may mention that the *Pall Mall Gazette* is astir in the matter. A number of dissatisfied allottees are combining, through the agency of our evening contemporary, and united efforts ought to be able to effect some useful purpose.

British Electric Traction shares, after allowing for deduction of the dividend, are 4s. down on the week, the company's senior issues undergoing no change. New General Traction shares are 3¼—4, and it is said in the market that this company has been doing well lately in connection with some of its provincial work. Anglo-Argentine Trams are 4, Buenos Ayres and Belgrano "A" 5, the "B" 4½. Potteries Electric Traction prices are 11 and 10½ for Ordinary and Preference respectively. The London Electrical Cab Company is in some difficulty over its bankruptcy affairs.

Central London Deferred half-shares, as mentioned above, are up ¼, the other issues remaining hard at last week's prices. The "vibration" scare has spent its force for the moment, but we should not be at all astonished to see it in strong evidence again after Christmas. The advance in Waterloo and City Stock has made no further headway, and City and South London has not yet started to recover the points lost by the Stock on the announcement of the fresh issue of shares at 5½. Metropolitan and Metropolitan District Stocks are both weak, the electrifying of the lines being regarded as almost a mythical matter in the Stock Exchange.

A fresh fall in Eastern Telegraph Ordinary Stock has taken the price below 140, but the rest of this market is steady; Marconi's Wireless Telegraphy are 3⅝ to 3¾, the meeting of the company on Tuesday last not assisting the price of the shares. Probably our contention is becoming recognised, and the public will not buy Marconi's on anything but a business basis.

Welsbach issues are much better on what is understood to be the success of the company's new electric lamp. The Nernst board does not appear able to settle its differences satisfactorily so far, and the price of the shares is dull, notwithstanding the good report published recently. The telephone market is featureless.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Dec. 13th.	Closing Quotations Dec. 19th.	Business done during week ended Dec. 19th, 1900. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
822,700	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	52 — 55	52 — 55	53½	52
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	97 — 99	97 — 99	98½	97½
3,088,540	Do. do. Deferred	Stock	...	18s. %	£1 7s.	9¾— 10¼	10 — 10½	10 5/16	10⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	3 — 3½	3 — 3½	3	...
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	170 —180	170 —180	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	103½	103
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 —104 %	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	10 — 10½	10 — 10½	10⅜	10 1/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	138 —143	136 —141	138½	136½
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	96 — 99	96 — 99	97	96
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	110 —114	110 —114	112½	110
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	13¾— 14¼	13¾— 14¼	14⅛	13¾
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) £6 pd.	10	...	...	...	9¼— 9¾	9¼— 9¾	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	113 —118	113 —118	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	..
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	99 —102%	99 —102%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5½%	10½— 10¾	10½— 10¾	10 7/16	10½
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	15 — 15½	15 — 15½	...	...
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	31 — 33	31 — 33	31⅞	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	48 — 52	48 — 52	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	104 —107	104 —107	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	2½%	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	5 %	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	6 %	5 %	4⅜— 4⅝	4⅜— 4⅝	4½	4⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	5 — 5¼	5	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 99	96 — 99	...	...
500,000	Do. 4 % Deb. Stock Red.	100	...	...	...	101 —104	101 —104	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	101 —104	101 —104	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	123 —128	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4½— 5	4½— 5	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	5 — 5⅛	5 — 5⅛	...	...
23,361	Do. do. Nos. 16,640 to 40,000 £3¼ pd.	5	...	...	...	3¼— 3⅜	3¼— 3⅜	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Brss. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	7 %	14 — 14½	14 — 14½	14¼	14
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	103 —106	103 —106	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	103 —106	...	...
88,321	West India and Panama Telegraph	10	¾%	2 %	⅝%	⅝— ⅞	⅝— ⅞	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	6 — 7	6 — 7	6⅝	6½
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	105 —108	105 —108	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	7¼	...
12,000	Do. do. 7 % Cum. Pref....	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9½— 10½	9½— 10½	9 1/16	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 6	5½— 6	5⅝	5½
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6½— 7	6½— 7	6⅞	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	4½%	...	...	110 —113	110 —113	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	10 %	6 %	4 %	9 — 10	9 — 10	9⅝	9⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	13 — 14	13 — 14	13⅜	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	125 —130	125 —130	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11½— 12½	11½— 12½	12¼	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	108 —111	108 —111	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	4 1/16	4⅛
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	102 —105	102 —105	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2¼	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4 — 5	4½— 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	98 —101 xd	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	12½— 13½	12 — 13	12⅝	...
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	112 —115	112 —115	113	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	98 —101	98 —101	100	99½
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	...	..
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	100 —103	100 —103	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
70,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	12 %	13 %	12 — 13	12 — 13	12 1/16	12⅛

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Dec. 12th.	Closing Quotation Dec. 19th.	Business done week ended Dec. 19th, 1900. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	9 — 10	8½— 9½	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	...	6 %	...	14 — 15	13½— 14¼xd	13⅜	13 11/16
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12⅝	12 7/8
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	122	121⅛
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	½— ⅝	½— ⅝	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	⅝— ¾	⅝— ¾	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
70,000	British Insulated Wire Ord.	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅜— 6¼	5⅜— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	3 %	5 %	6 %	1⅝— 1⅞	1⅝— 1⅞	1 11/16	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	106 —111	107	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	103 —105	103 —105	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	12½%	15 %	15 %	12½— 13½	12½— 13½	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5¼— 5⅝	5¼— 5⅝	5⅝	5 15/16
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	110 —114	111 —115	114	112
206,297	Central London Railway, Ord. Shares	10	...	...	...	9¼— 9¾	9¼— 9¾	9⅝	9¼
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅝— 5¼	4⅝— 5¼	5⅛	5
78,703	Do. do. Def. do.	5	...	...	...	4 — 4½	4 — 4½	4½	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	52 — 56	52 — 56	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000 ...	10	...	...	...	4½— 5½	4½— 5½	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	...	6 %	7⅛%	3½— 4	3½— 4	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1⅞— 2¼	1⅞— 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	90 — 92	90 — 92	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	2	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	7 %	...	2⅜— 3¼	2⅜— 3¼	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	12½— 13½	12½— 13½	12⅝	...
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5¼— 5⅜	5¼— 5⅜	5 1/16	5¼
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21⅜	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3⅜%	8⅝— 8¾	8⅝— 8¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5	13¼— 13½	13¼— 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	38 — 42	38 — 42	40¾	39
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...%	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10 — 11	10 — 11	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5¼— 5⅜	5¼— 5⅜	5 1/16	5⅜
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	94 — 97	94 — 97	96	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 104—107.
Consolidated Telephone Construction and Maintenance, ⅛—¼
National Electric Free Wiring, 12/6 paid, ½—⅝.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—11.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11½—12½; 1st Preference Cumulative 6 % £5 (fully paid), 6¾—7. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, December 19th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	30/-	30/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	5¾d.	5¾d.	..
a ,, Caustic (76/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2½d.	2½d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £140	dec.
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8d.	8¼d.	¼d. dec.
c ,, Wire, basis	per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11½d.	½d. dec.
c ,, ,, (solid drawn) ..	per lb.	10½d.	11d.	½d. dec.
g Copper Bars (best selected) ..	per ton	£96	£96	..
g Copper Sheet	per ton	£96	£96	..
g ,, Rod	per ton	£96	£96	..
e ,, (Electrolytic) Bars ..	per ton	£92	£93 10	30s. dec.
e ,, ,, Sheets ..	per ton	£90	£92	£2 dec.
e ,, ,, Rod ..	per ton	£94	£95 10	30s. dec.
e ,, ,, H.C. Wire	per lb.	9¼d.	9½d.	¼d. dec.
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/6	6d. dec.
h India-rubber, Para fine	per lb.	3/10½	3/9½ to 3/10½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	52/9	60/7½	7s. 10½d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£11 10	£11 10	..
g Lead, English Ingot	per ton	£16 5 to £16 7 6	£16 5 to £16 7 6	..
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/8	From 1/8	..
o Platinum	per oz.	£3 18	£3 18	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£120 to £121	£122 to £122 10	£2 dec.
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	5½d.	5½d.	½d. inc.
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ond.)	per ton	£23 2 6	£23 2 6	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakespeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd

INSTITUTION OF ELECTRICAL ENGINEERS.

ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.

By W. Duddell, Wh. Sc., Associate.

(*Paper read December 13th*, 1900.)

It may be thought by some that the title of this paper is rather contradictory, in that there should not be any variation in the current through a direct-current arc. I will therefore explain at once that I simply use the term "direct current" as implying that the current is supplied by cells or by a direct-current dynamo, and not as implying that the current is necessarily constant in value. It may also be as well to state that by *arc* I do *not* mean *arc lamp*, as all the effects to be described are quite apart from those produced by regulating mechanisms.

The effect of varying the current through the direct current arc very slowly, so slowly in fact, that the carbons have time to burn into shape corresponding to each value of the current, has been investigated by many experimenters, but it is to Mrs. Ayrton * that the honour belongs of giving a complete investigation of all that occurs when any of the variables in the direct-current arc are changed in any way. The other extreme, namely, very sudden changes in the current, has also been investigated by Mrs. Ayrton,† thus leaving a gap in the experimental evidence as to what occurs between very slow variations and isolated sudden changes in the current.

The present paper is an attempt partly to fill this gap by giving an account of what occurs when the current is periodically varied more or less rapidly over a range which is very small compared with the mean value of the direct current.

The current through a direct-current arc supplied with power from any circuit may vary either owing to changes taking place in the circuit, such as variations in E.M.F. or resistance, or owing to effects in the arc itself, such as hissing, humming. Although any variation in the current naturally entails a corresponding change in the arc itself, it will, I think, be found convenient to classify the observed effects according to whether the primary cause of the variation is in the arc, or in the circuit which supplies it.

PART I.—Cause of the Variation of the Current in the Circuit Supplying the Arc.

The effects of varying the current may be divided under four heads, viz., the effect on the P.D. between the terminals of the arc, on the light emitted, on the shape of the craters, and on the vapour column. These will be considered in order. I shall assume in all cases in Part I. that the amplitude of variation of the current from the mean is small, generally much less than 10 per cent., and that the arc experimented on is neither hissing nor humming.

Effect on the Potential Difference Produced by Variations of the Current.—If the current varies very slowly, then the relation between the P.D. current and length is that given by Mrs. Ayrton's curves. Directly the rate of variation is increased, so that the carbons have not time to burn into shape, corresponding with the instantaneous values of the current, the relation will be changed, and it is conceivable that *if* the rate of variation were high enough, and the amplitude small enough, the conditions of the arc would in no way be changed, so that the ratio of the change in P.D. to the corresponding change in current would be a constant, and equal to the true resistance of the arc. I shall show later that this assumption, which is the basis of several experiments on the resistance of the arc, notably those by Messrs. Frith and Rodgers,‡ requires a much higher rate of variation of current than they employed.

One of Mrs. Ayrton's curves, contained in a letter by Prof. Ayrton to the *Electrician*,§ illustrates very well how the connection between the P.D. and current depends on the rate of variation of the latter. This curve shows that the *first* effect of *suddenly increasing the current* through a cored-solid arc‖ is to cause a *transient rise in the P.D.* between the terminals; the effect of a *slow increase of current* being, as is well known, to produce a *decrease in the P.D.* This first transient rise in the P.D. which was obtained with a cored-solid arc, was also, I believe, obtained with a cored arc, but I am unaware of its having been observed for a solid arc.

Thinking that this might be due, as pointed out by Prof. Ayrton, to the extreme quickness of the phenomenon when *both* carbons were solid, I tried to record the transient rise in P.D. for the solid arc by means of an oscillograph, the sudden increase of the current being obtained by discharging a condenser through the arc. This experiment was successful, and a transient rise in P.D. was observed, *the P.D. and current increasing together, but only for about* $\frac{1}{1000}$ *second.* At the end of this very short time the P.D. decreased with an increase of current in the ordinary way.

If it can be assumed that during this first $\frac{1}{1000}$ second the conditions of the arc are not changed, then the solid arc has a positive resistance, contrary to the results obtained by Messrs. Frith and Rodgers, and it is, at any rate, evident that, had the frequency of their superimposed alternating current been 5,000 ~ per second instead of 250 ~ per second, the sign of the resistance as obtained by them would have changed, though I do not say that even at that frequency its true value would have been obtained. In any method for measuring the resistance of the solid arc which depends on the change in the P.D. produced by a change of current, these changes must, therefore, take place in less than $\frac{1}{1000}$ second in order not to allow the arc conditions to change; results to be described later indicate a still shorter time.

I will not, however, pursue this subject any further, as it would unduly extend the length of this paper to include a description of a complete series of experiments on the resistance of the arc which I have recently completed.

Effect on the Light Emitted Produced by Variations of the Current.—It is well known that the light of the arc varies when the current is changed, though how small and rapid the variation in current may be and yet produce a perceptible change in the light does not seem to have been investigated. Prof. Fleming and Mr. Petavel* and Mr. Burnie† have determined the instantaneous values of the light and current in the case of alternate current arcs, and have found that the variation in light roughly follows the variation of the current, the maximum luminous intensity occurring about $\frac{1}{1000}$ second later than the maximum current. Herr Görges‡ has also noticed that the variations in the current due to the teeth on the armature of a dynamo produced an appreciable variation in the light at the rate of 300 per second.

In order to test how rapid and how small a variation of the current from the mean could be detected in the light of the direct current arc, I arranged an arc so that its image, as seen through a central slit parallel to the carbons, was projected on to a rapidly falling photographic plate, the instantaneous value of

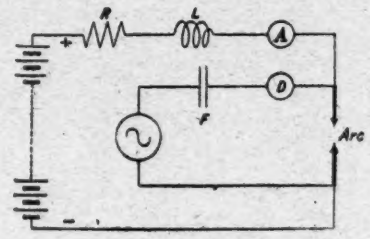


Fig. 1.

the current being recorded simultaneously on the same plate by means of an oscillograph. The small quick variations of the current through the arc were produced by passing the oscillatory discharge of a condenser in series with a self-induction through it, so that the arc current consisted of a large constant part on which was superimposed a small ripple which died away after a few oscillations.

By this method I find that in an 8-ampere solid arc a *distinct variation is produced in the light emitted by both the + crater and the vapour column when the amplitude of the variation of the current from the mean is only 3 per cent. and the frequency of these superimposed variations is as large as 4,300 ~ per second.* At this frequency the variation in light became indistinguishable when the amplitude of the variation of the direct current was reduced to 2 per cent.

Owing to the difficulty in estimating the points of maximum density in the band on the plate which represents the light emitted in consequence of the smallness of the variation of the current and therefore of the light, I was unable to be certain whether the maximum light lags behind the maximum current; but if it does, the lag is very slight, not exceeding $\frac{1}{10000}$ second for an 8-ampere solid arc.

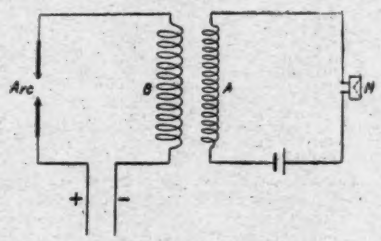


Fig. 2.

It must be remembered that the above variations of light are those of the actinic rays which affect the photographic plate; the visual will probably vary in a similar manner, though possibly not to the same extent.

Effect on the Craters Produced by Variations of the Current.—Mrs. Ayrton tells me that she noticed that the variations in the current used by Messrs. Frith and Rodgers, who superimposed an alternating current of 0·5 to 1·0 ampere R.M.S. value, at frequency of 100 ~

* The *Electrician*, Vols. xxxiv., xxxv., and xxxvi.
† The *Electrician*, 1895, Vol. xxxiv., pp. 471, 541.
‡ *Proceedings of the Physical Society*, 1896, Vol. xiv., p. 307.
§ The *Electrician*, 1896, Vol. xxxvii., p. 321.
‖ "Solid," "solid cored" and "cored" arc mean, respectively, arc between two solid carbons, between one solid and cored, and between two cored carbons; the top or + electrode being always placed first.

* *Proceedings of the Physical Society*, 1896, Vol. xiv., p. 115.
† The *Electrician*, 1897, Vol. xxxix., p. 849.
‡ *Electrotechnische Zeitschrift*, 1895, Vol. xvi., p. 54[2].

per second on a 10-ampere direct current arc, so altered the shape of the ends of the carbons that she could easily distinguish them from normal carbons formed without any variation in the current. I find that if the superimposed alternating current be reduced to 0·1 ampere under the same conditions, the ends of the carbons appear unaffected.

Effect on the Vapour Column Produced by Variations of the Current.—Sounds.—Corresponding with each value of the current through the arc there is probably a definite cross-section of the vapour column, so that if the current varies rapidly through an arc of fixed length, the volume of the vapour will also vary and sound-waves will be given out. This, I believe, is the generally accepted explanation of the humming of the alternate current arc.

In the case of the direct current arc, sounds are also emitted even when the variations in the current are very slight. For example, the variation of current caused by the commutator segments of a direct current dynamo passing under the brushes can be heard in the arc. This variation of the current caused by the commutator segments, even when in good condition, was found by Messrs. Frith and Rodgers * in the case of a 5-KW, two-pole machine to vary between 2·5 and 9 per cent. of the mean current according to the position of the brushes.

Another striking example of how sensitive the arc is to small variations in the current is furnished by the fact that a Wehnelt interrupter, working an induction coil on the direct current street mains, will cause any arc supplied by the same mains to give out the same noise as the interrupter itself, even when a considerable distance intervenes between the place where the arc is connected with the mains, and where the interrupter and coil are joined on, as observed by Herr Simon,† Mrs. Ayrton, and Mr. Jervis Smith.‡

It must be clearly understood that the arcs here referred to are normal silent arcs; that is, if they were supplied with a really steady current they would have been practically silent.§

In order to determine what variation in the current was necessary to cause the arc to emit a clearly audible note, the current from a high frequency alternator, kindly lent by Sir D. Salomons, was superimposed on the direct current by the method shown in fig. 1. The current from the alternator passes through a condenser F, a dynamometer D, and the arc in series; and it is practically prevented from flowing through the cells which supply the arc by the self-induction L. The direct current is prevented from flowing through the alternator by the condenser F.

It was found by this means that a 10-ampere direct current, solid or cored arc, length 3 to 5 mm.. would produce a distinct note even if as small a R.M.S. current as $\frac{1}{1000}$th ampere, as measured by D, was superimposed on the direct current for frequencies of the added current from a few hundred up to 8,000 ~ per second. Thus *a variation of the order of one part in* 10,000 *from the mean current will alter the vapour column sufficiently to produce sound waves.*

Further experiments with another alternator and R.M.S. superimposed currents of $\frac{1}{250}$th to $\frac{1}{10}$th ampere on a 10-ampere solid arc, proved that the sounds only became inaudible at frequencies approaching 30,000 ~ per second.

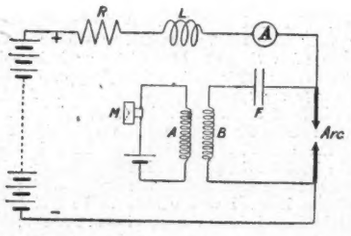


FIG. 3.

At these frequencies I am uncertain whether the arc had really ceased to give a note, as the ear fails to detect sounds of so high a pitch.

This sensibility of the arc for very small changes in its current explains the fact that not only can rapid variations of current in any circuit supplied from the same generator as the arc be heard in the arc, but also variations of current which occur in a totally independent circuit supplied by a separate generator can be detected in the arc due to mutual induction between the two circuits.

Arc as a Telephone Receiver.—The fact that the arc is sensitive to such small variations in the current and over such a wide range of frequency, at once suggests that the direct-current arc might be used as telephone receiver. This suggestion, which was made in a leader of the *Electrician* in 1899, had already been carried out by H. Simon‖ in 1898.

The method used by H. Simon for superimposing a microphone current on the main arc current is shown in fig. 2, in which A and B are two coils having mutual induction, and M the microphone. The current through A varies when M is spoken into and induces E.M.Fs. in B, which vary the current through the arc in such a way that it reproduces sounds and even speech distinctly.

The variation of the current through the arc obtained by this method is not as large as it might be, as the E.M.Fs. induced in B have to send currents round the whole arc circuit, including any steadying resistances, and also through the self-induction in the armature, if a dynamo is used, instead of only through the arc where the varying currents are actually required. I have obtained a better result by replacing the alternator of fig. 1 with a microphone and mutual induction as shown in fig. 3. A and B are the two coils of a mutual induction, F a condenser of about two or three microfarads, and L a high self-induction, the object of the self-induction being to prevent the microphone currents flowing round the cells instead of through the arc.

With this arrangement and suitable arc conditions, to be explained later, *the arc will speak sufficiently loudly and clearly to be heard at a distance of* 10 *to* 12 *feet in a quiet room.* [Experiment.] The sound-waves given out by the arc are, therefore, of such an intensity that when the energy is spread over an area of 20 feet diameter, the ear placed at any point can hear speech distinctly. It seems probable that if all the energy available could be collected and concentrated in one car, very powerful sound-sensations might be produced.

The loudness of the sounds given out by the arc is increased by lengthening the arc, as this increases the volume of the vapour column which emits the sounds. It would also seem as if increasing the main current which increases the cross-section of the arc should also be beneficial, but experimentally I have not found any appreciable gain. The best results have generally been obtained with a current of 10 to 12 amperes, carbons 11 to 13 mm., and an arc length of 20 to 30 mm.

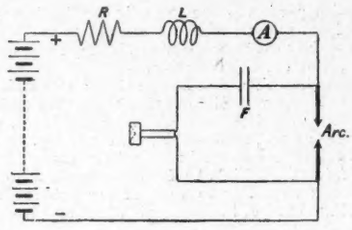


FIG. 4.

To obtain these long lengths with ease it is necessary to use cored carbons or some other means of introducing foreign bodies, such as salts of potassium and sodium, into the arc, for there is not much doubt that the stability of the arc between ordinary cored carbons is due to the presence of potassium silicate in the cores.* (See also Appendix I.) These salts may be introduced either by soaking the carbons in their solution or by using them as cores. Mr. Jervis Smith has recommended the insulator glass as a core, which I find works well.

Arc as a Telephone Transmitter.—Before leaving the subject of the use of the arc as a telephone it will be convenient to consider its use as a telephone *transmitter*, though this subject strictly belongs to Part II. of this paper.

H. Simon found that if he replaced his microphone in fig. 2 by a telephone receiver, *any sounds made near the arc were heard in the receiver.* In this case, as before, I find it preferable to modify his method by connecting the receiver in series with a condenser between the terminals of the arc, as in fig. 4.

A sound-wave striking the arc may affect it in two ways, either by vibrating the arc as a whole and varying its length or the waves of condensation and rarefaction may alter the cross-section of the arc: both of these effects will tend to alter the apparent resistance of the arc, and hence vary the current through it.

The sounds obtained in the telephone receiver when using the direct-current arc as a transmitter are not generally very satisfactory, as, besides not being very loud, they are obscured by the extraneous sounds due to the small spits and hisses which occur in the arc each time the air gets to the + crater due to any slight defect in the carbons. If a common pair of carbons be used containing cracks and impurities, the noise in the receiver is sometimes unbearable, although there is no outside source of disturbance of the current through the circuit.

In all experiments on the arc as a telephone transmitter or receiver, it is essential that the current generator should be free from rapid variations, or extraneous sounds will be produced. If a dynamo has to be used, then the variations of the current produced by the commutator segments may be minimised by inserting a large self-induction in series with the arc, as in figs. 1, 3 and 4. This self-induction serves the double purpose of keeping extraneous variations of the current out of the arc, and of preventing the variations we desire to observe from being dissipated in the source of supply.

Thus we see that *the direct-current arc is not only extremely sensitive to small variations in its current of almost any frequency, but also that it is affected by such small changes of outside conditions as sound-*

* *Proceedings of the Physical Society*, 1896, Vol. xiv., p. 307.

† *Annalen der Physik und der Chemie*, 1898, Vol. lxiv., p. 233.

‡ The *Electrician*, 1899, Vol. xliv., p. 16.

§ Absolute silence is almost impossible, as the least want of homogeneity, or impurity in the electrodes, causes small spits and sounds.

‖ *Annalen der Physik und der Chemie*, 1898, Vol. lxiv., p. 233.

* See Duddell and Marchant, *Proceedings of the Institution of Electrical Engineers*, 1899, Vol. xxviii., p. 66; Blondel, International Congress of Electricity, Paris, 1900.

waves produce. Whether this sensibility can be turned to useful account in telegraphy or telephony remains for future experiment to decide.

PART II.—Current Caused to Vary by the Arc.

Humming.—Mr. Trotter* discovered that the direct-current humming arc rotates, including a coma-like appearance at the + crater, and he also found that the current through the arc varied periodically, the frequency of these variations being the same as the pitch of the humming sound produced, and as the speed of rotation of the arc.

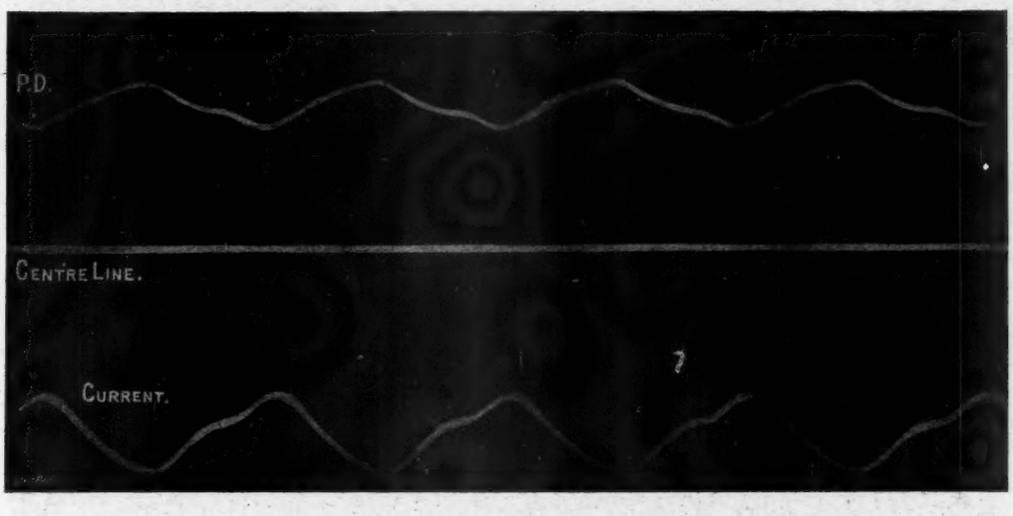
In order further to investigate the connection between the variation of the light P.D. and the current, I have recorded the P.D. and current by means of an oscillograph, the humming arc experimented on being used as the source of light to illuminate the oscillograph mirrors. The arc was so inclined that only the light from the + crater and a small part of the vapour column reached the mirrors. So that the density at any point of the lines represents the photographic intensity of the light emitted at that instant in the direction of the mirrors by the + crater and part of the vapour column, and the distance of the point from this zero line measures the P.D. or the current as the case may be.†

A typical example of the variations observed in the humming arc is given in fig. 5, from which it will be seen that the P.D. current and light emitted in a fixed direction vary in a regular periodic manner with the same frequency.

The variation of the current, which is about 6 per cent. from the mean, is not sufficient to account for the large variation in the light emitted in the direction of the mirrors. This periodic variation of the light is most probably due to the fact that the arc rotates so that the + crater alternately either supplies light to the oscillograph mirrors, or is prevented from doing so by being on the other side of the + carbon. The periodic time of the variations of the light will, of course, be unaffected by a change in the position from which the arc is observed, but the times at which the light maxima occur relatively to the times at which the current is a maximum will depend on this position.

Humming Arc.

Carbons + 11 and − 9 mm. Solid "Apostle." Mean P.D. = 50·5 volts. Mean current = 15·2 amperes.

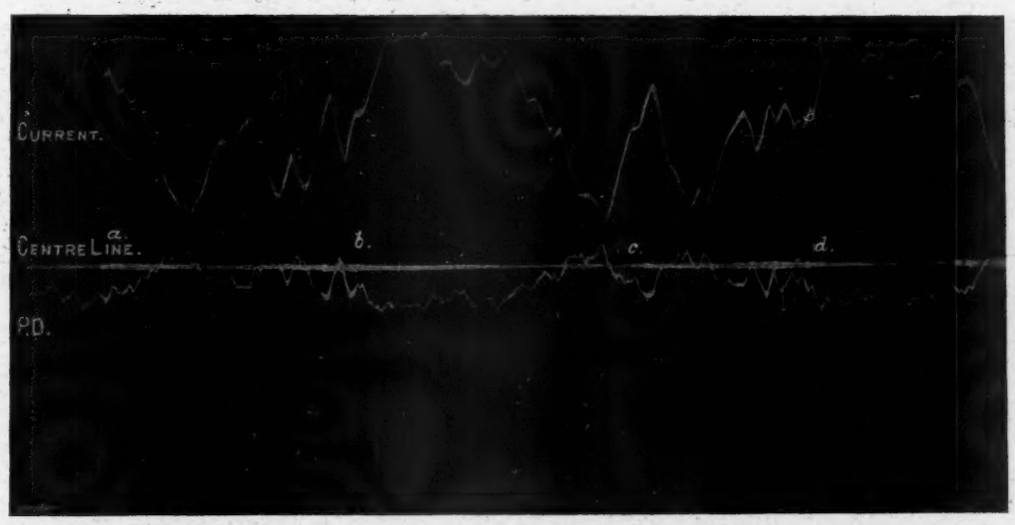


Scales:—1 mm. = 0·5 volt = 0·186 ampere = $\frac{1}{64\cdot00}$ second. Centre line = 40 volts = 20 amperes.

Fig. 5.

Hissing Arc.

Carbons + 11 and − 9 mm. Solid "Apostle." Mean P.D. = 38 volts. Mean current = 22·3 amperes.



Scales:—1 mm. = 0·5 volt = 0·1 ampere = $\frac{1}{64\cdot00}$ second. Centre line = 40 volts = 20 amperes.

Fig. 6.

Thus besides the rotation of the humming arc and the variation of the current observed by Mr. Trotter, I find that the light and P.D. vary with the same frequency, so that in the humming arc the frequencies of the rotation of the arc, and of the variations in the P.D. current, and light emitted in a given direction, are identical with the pitch of the note given out.

Hissing.—It has been shown by Messrs. Frith and Rodgers* and by Messrs. Duddell and Marchant,† that when a direct-current arc

* The *Electrician*, 1894, Vol. xxxiii., p. 298.

† In figs. 5, 6 and 7, the centre line is not the zero line, but represents 20 amperes and 40 volts.

* *Proceedings of the Physical Society*, 1896, Vol. xiv. p. 320.

† *Journal of the Inst. of Elec. Engineers*, 1899, Vol. xxviii., p. 86.

supplied from a constant source hisses, the current through it and the P.D. between its terminals vary rapidly; and M. Blondel * and Mr. Brown † have also found that the light emitted varies.

If the current through the humming arc be increased until the arc hisses, the variations in P.D. current and light change, I find, in a most striking manner from the regular periodic variations of fig. 5 to the very irregular variations shown in figs. 6 and 7.

In spite of the very irregular nature of the variations, which irregularity is not surprising in view of Mrs. Ayrton's explanation of the cause of hissing given before this Institution last year, I think that they can be separated into two kinds, a large comparatively slow variation and a rapid superimposed one. The light given out is alternately bright, with rapid variations in intensity, *a* to *b*, fig. 6, and dull with hardly any variations, *b* to *c*; the slow variation of the light corresponding with the larger variation of the current; the maximum light and current do not, however, occur simultaneously.

In view of the explanation given in the case of the humming arc that the large variations of the light is due to its rotation, and in

Hissing Arc.

Carbons + 11 and − 9 mm. Solid "Apostle." Mean P.D. = 44·5 volts. Mean current = 19·5 amperes.

Scales:—1 mm. = 0·5 volt = 0·1 ampere = $\frac{1}{6400}$ second. Centre line = 40 volts = 20 amperes.

Fig. 7.

view of the fact that the hissing arc is also probably rotating, as pointed out by Mrs. Ayrton, I think that the larger variations of P.D., current, and light in the hissing arc must also be due to the rotation of the arc. If this is the case, then the brightest parts of the curves are produced by light from the + crater and the rapid variations of density chiefly present in these parts of the lines are due to the rapid variation of this light from the + crater. [Experiment.]

Now these rapid variations in the light correspond with the small rapid changes in the current and the P.D., so that *the rapid variations of P.D. and current correspond with the variations of the light emitted by the + crater, and the large slow variations with the rotation of the arc as a whole.*

Considering one of the larger light maxima, say from *a* to *b*, or *c* to *d*, fig. 6, during which the oscillograph mirrors receive the light from the + crater without being obstructed by the carbon, it will be seen that in many cases the maximum light and minimum P.D. occur practically at the same instant, whilst the *maximum current occurs later than the light maximum.* This is the opposite to what occurs when the current through the arc is varied by any *change in the circuit*, for in this latter case *the maximum current occurs before the light maximum.*

The periodically recurring sequence of events in the hissing arc is thus probably as follows, putting aside the rotation of the arc as a whole. Owing to the crater becoming too large for the end of the + carbon, the air obtains access to the crater surface as found by Mrs. Ayrton, the oxygen of the air there combines with the carbon, causing a rise of temperature, an increase of brilliancy, a drop in the P.D., followed very slightly later by a rise in the current.

I think that the above observations on hissing and humming are explained by, and confirm, the fundamental nature of Mrs. Ayrton's discovery of the cause of the hissing of the arc.

(To be continued.)

* *La Lumière Electrique*, 1892, Vol. xliii., p. 54.
† *Physical Review*, 1898, Vol. vii., p. 210.

ELECTRIC RAILWAY SIGNALLING.

At the Institution of Civil Engineers on December 11th, three papers were read, entitled "The Signalling on the Waterloo and City Railway," and "Note on Signalling Outlying Siding Connections," by Mr. A. W. Szlumper, M.Inst.C.E., and "Signalling on the Liverpool Overhead Railway," by Mr. S. B. Cottrell, M.Inst.C.E.

The Waterloo and City Railway, as previously described in the Minutes of *Proceedings of the Institution* (Vol. cxxxix.), was an electrically-worked underground railway, 1½ miles in length. It was a double line, in separate tunnels, with a station and accommodation for shunting the trains at each end. Trains ran every six minutes, the journey occupying about six minutes. There were two signal cabins, one at Waterloo, and one at the City, the former containing 16 levers, and the latter 18 levers. The line, however, was practically divided into two block sections by the provision of signals about half-way between the stations, such signals consisting of an electric lamp fixed to the wall of the tunnel, electrically con-

trolled from both boxes and by clearance bars or treadles. In addition to the ordinary mechanical interlocking, the Sykes electric lock-and-block system had been largely introduced, and as a further safeguard "slipper bars" were fixed at a short distance in front of the more important signals by means of which the current to the electric motors was automatically cut off should a train pass the "slipper bar" when the signal was at danger. The "starting" signals at the stations had double arms, the upper one being a "right away" signal, the lower one being a "draw ahead" signal. Both these arms were worked by the same lever by means of a Sykes "electrical selector." The "stop" signals at the stations consisted of ordinary ground discs, which were also provided for shunting movements. Treadles or fouling-bars were extensively used; they consisted of an angle-bar about 35 feet in length, balanced on pivots and connected to a contact-making switch. In lieu of the ordinary repeaters, bells were fitted in the signal boxes which rang when any signal failed. This was effected by passing a wire through a series of signals by means of contact makers on each signal and upon their corresponding lever in the signal box, terminating in a bell which started ringing should any contact be broken. Facing-points were fitted with ordinary facing-point bolts, also Sykes electrical point-detectors, one being fixed to each stock rail on a pair of points and connected to and working with the tongues. Both tongues had to be dead home before the selector was operative, and until then the point lever was locked by an electric lock. The block instruments used were Sykes lock-and-block instruments, which were electrically interlocked with the levers and signals. All the lights in the signals and discs consisted of 8-c.p. glow lamps in duplicate and were repeated in the signal boxes by pilot lights.

The second paper described some modern methods of electrically controlling outlying siding connections. One system described was applicable to a railway where an electric lock-and-block system was installed. The siding connection was controlled by a key, the removal of which, from an instrument, locked up all conflicting signals and broke down the block instruments until the key was returned; no outdoor signals at the siding were necessary. Another system described consisted of the provision of a ground box and outdoor signals at the siding, locking instruments being provided at both the section and siding boxes. When the siding was to be used, the switching in of the siding box locked up the starting signal at

the section box by means of an electric lock, and released an electric lock on the siding signal, the switching out of the siding box restoring the section box signals and instrument to their normal condition. A special feature of this scheme was electrically locking up the entrance to the siding box from the section box. Another system described consisted in the provision of a ground box and of outdoor signals at the siding connection. When operations were to be carried out at the siding, the box was switched in as a section box, and electric locks on the signals were released; during shunting operations the siding box was treated as a section box, and when completed the box was switched out, and the signals again became electrically locked from the section box.

The third paper described the system of automatic electric signalling in use on the Liverpool Overhead Railway, which, originally promoted to facilitate passenger transit to and from the docks, had developed into a line nearly seven miles in length, and, in addition to fulfilling its original purpose, provided rapid access to Liverpool from two important suburbs, and by means of an electric tramcar system owned by the company from other suburbs. When the line had been originally constructed as a dock railway with many stations, automatic electric signals had been introduced, in order to avoid the expense of men and maintenance, but with the extensions in the suburbs the automatic system had had to be supplemented at termini and junctions by ordinary mechanical signals. The intermediate stations were divided into 14 block sections; each block had a station at its commencement, and since the length of the blocks was short, each station was equipped with only four signals, viz., one home signal and one starting signal for each road, the starting signal being practically the distant signal for the station in advance. A train leaving a station passed the "breaking" contact, putting the starting signal to "danger"; it then passed the "making" contact, which pulled off the home signal of the station it had just left, and the starting signal of the station in the rear. The circuit between the making contact and the other signals was made through a switch fixed on the arm of the starting signal, so that should the latter fail to go to "danger," the circuit could not be completed and the line behind would be blocked. The making and breaking contacts were actuated by a striking board fixed on the last coach, so that should a train break in two, the signals would not be operated. This automatic arrangement applied to all intermediate stations, and where the automatic system merged into mechanical, the alteration took place at the home signal in one direction and at the advance starting signal in the other, that was, on the up road the advance starting signal was the first automatic signal, and on approaching the termini the distant signal was the first mechanical one. The current for working the signals was supplied from accumulators at 50 volts pressure; two sets of 27 cells were situated at each station; and these were charged in series from the generating station. These accumulators also provided light to the stations. The expenditure of electric energy in current was very small. Each station comprised four signals, each worked with a lowering current of 5 amperes at 40 volts, and with a holding current of 0·25 ampere at 40 volts. With a three-minute service for 20 hours a day each signal would be lowered 400 times, requiring therefore 2,000 ampere-seconds, or, say, 0·5 ampere-hour, per signal per day. The entire station would require 80 watt-hours per day, and the total system 1,040 watt-hours. This, however, did not include the holding-off currents. Assuming each signal to be held down 1½ minutes, it would be down 600 minutes per day, requiring 150 ampere-minutes, or 2·5 ampere-hours, or five times as much as for lowering. In the first few months there had been occasions of signals failing to go to "danger," but experience enabled such failures to be eliminated, and reduced the number of other failures, which now amounted to an average of only one in 14,156,857 operations.

THE PARIS EXPOSITION OF 1900.*

By CARL HERING.

(*Continued from page 967.*)

The two new electrically-operated extensions of several steam railroads into the central parts of Paris; the new and much-needed electric railroad to Versailles; and the new conduit road in Paris, are all of interest. A surface contact line and one using accumulators, are also being tried in Paris. The Western Railroad, one of the largest steam railroads of France, is making very extensive preparations toward introducing electric traction on its lines by more improved methods than its Heilman locomotives. If our steam railroads were as enterprising, the replacing of steam by electric traction would progress more rapidly here. Through the kindness of Mr. Clerault, the chief engineer of this enterprising steam railroad, our Institute had the pleasure of accepting an invitation for a personally-conducted visit to its interesting plant. It has already in operation in part, a large three-phase power station near Paris, accompanied by extensive laboratories; has constructed an electrical extension of its steam lines toward the centre of the city; is building the new electric line to Versailles over an excellently constructed and well graded private roadway, and has under construction a number of electric locomotives. Paris is therefore at last beginning to avail herself of the advantages of electricity for traction, and will unquestionably be very greatly benefitted thereby. If, with this modern traction force, a more modern and more American system of managing and operating the city tramways were introduced, the Parisians, the many visitors and the owners of the tramways, would all be the gainers.

In the Exhibition itself may be mentioned the two miles of moving platform which differed from the one in Chicago in that the motors were stationary while the rails moved. The third rail electric railroad paralleling it, but running in the opposite direction, was virtually an American exhibit, and was managed more like American roads, making a refreshing contrast to the wretchedly managed tramways and omnibuses in the city. Both the platform and this railway were fed from two 800-H.P. induction motor-generator sets made in this country, the induction motor, started by its mate, being one of the largest ever made. The conduit road which was shown, was also virtually one of those developed in this country. A short section of the "suspended" railway was exhibited, but whether this struggle for recognition was successful seems questionable. Another curious departure shown in operation was the trolley automotor, a system of running electrically-driven vehicles on ordinary roads, but taking current from an overhead trolley wire. The novel feature was, that the small contact carriage running on the two wires was geared electrically to the motors by means of a local three-phase current, so that it tended to travel slightly faster, thereby always leading and keeping the connecting cable taut. A field for it might exist where omnibuses are now used.

A number of large electric locomotives were exhibited, notably one from Berlin, showing that heavy electric traction is making progress. One weighing about 45 tons, exhibited by the French steam railroad known as the P. L. M., was operated with accumulators carried on a tender, but the claims made for it by the attendant were so remarkable, that a verification is desirable before they can be considered. Although it was dated 1896, I was told that it was "not yet" in constant use.

In electric lighting, one of the most interesting features was the *début* of the Nernst lamp. After long and tedious labours on the part of the General Electric Company, of Berlin, the interesting laboratory experiment of Nernst, that a filament of a non-conductor like magnesia becomes a conductor after it is heated—has been developed into a form of high efficiency incandescent lamp, which is now claimed to be ready for the market; but although several hundred were burned there daily, it was not possible to buy one. It resembles the usual incandescent lamp, except that the bulb is open; the filament is somewhat thicker and much shorter than that of a carbon lamp; the light is very much whiter and more brilliant. It can be lighted with a match, alcohol torch, or automatically by a platinum wire preheater with a magnetic interrupter. Either alternating or continuous currents can be used, but the filament must be exposed to the air. The lamps are made for 25, 50, and 100 C.P at 220 volts, and therefore do not yet compete directly with the usual 16-C.P. lamp. The efficiency is said to be 1·5 watts per candle, or about twice as good as the present carbon lamp of the same voltage. The filament is said to be made of magnesia mixed with the rare earths like zircon, thorium, &c. The life is claimed to be very satisfactory, though no figures can be obtained, but the perishable parts, valued at only 25 per cent. of the probable cost of the lamp, can easily be replaced, the bulb being open.

The material of which the filament is made, has a rapidly falling temperature coefficient, much worse that carbon, which would make it extremely sensitive to changes in voltage. This is overcome by a very ingenious method to which the present success of the lamp is due; it consists in placing a very fine iron wire in series with the filament, the wire being so proportioned that it is heated by the normal current to that temperature (about 450° to 500° C.) at which it has a very rapidly rising temperature coefficient; the resulting characteristic of the two in series is therefore a rising one. This fine wire consumes about 10 per cent. of the voltage. The price of the lamp, it is thought, may be about 50 cents.

Among the novelties in arc lamps which attracted some attention during the few days it was on exhibition, was the Bremer lamp, in which the carbons contain certain salts, like those of magnesia, together with fluor calcium, that deposits a white oxide on surrounding bodies, which acts both as a Nernst conductor and a white reflector, the carbons being inclined like the letter V. A reliable German authority found the efficiency to be 0·13 watt per hemispherical candle-power. The light is said to be steady and bright but soft.

The only enclosed arc lamps exhibited were from this country, directly or indirectly. These lamps, which are so largely adopted here, are scarcely known on the Continent, and in France, at least, it seems that they are not even wanted, on the ground that the light is too blue and unsteady, and the efficiency too low. As manual labour is much cheaper there than here, and arc lamps are not used nearly as much, the chief advantage of this lamp is not appreciated, at least not yet. The arc lights there are, as a rule, much steadier, and are almost universally connected to constant potential circuits, our series system being almost unknown. The general type of regulating mechanism which is in favour is that in which the coil applies a brake to an escapement wheel which tends to revolve by the weight of the descending carbon: the regulation is therefore very sensitive and gradual. Cored carbons of a fine quality are moreover almost universally used. Generally only two lamps are in series across the usual 110-volt mains, but in some cases as many as three are connected with an increase in light efficiency; in such cases the lamps are of the differential type, in

* Inaugural address by the President at the 147th meeting of the American Institute of Electrical Engineers, New York, October 24th, 1900.

which the regulating mechanism is actuated not only by a shunt coil but also by one in series.

The exhibits of electric chandeliers and like fixtures were mostly French, and were generally very tasteful, artistic, and often very beautiful, although frequently marred by external wiring, as with many of them concealed wiring is impractical. The accessories, on the other hand, such as circuit breakers, small switches, lamp sockets, motor starting resistances, &c., were frequently quite bad or too complicated, from an American standpoint. There would seem to be quite a market abroad for the better classes of American goods of this kind. It is hard to understand why electrically started fires are not more frequent on the Continent with such poor appliances of this kind that one finds in use there.

The relatively large number of exhibits of switchboard switches for breaking currents of very high voltage indicates the rapid introduction of high tension currents. In many of them the well-known double horn is used for extinguishing the arc, which is an indication of the effectiveness of this simple device.

A novel departure in switchboards, especially for dangerously high voltage machines, consisted in placing all the switching apparatus belonging to one machine, on or under a post or pedestal near the machine itself, and so that the attendant faces the machine. The actual switches are under the floor, where they are out of the way and easily accessible from a pit below, only the levers, hand wheels, and instruments being on the pedestal; the attendant is thereby protected from all the possible danger. It is the standard practice of the Oerlikon Company.

The use of silver fuse wire in place of lead alloys, by a very large German company, on the ground of greater reliability and constancy, deserves mention. For the same fusing current the amount of metal volatilised is the least for silver.

The non-interchangeable fuses of Siemens & Halske were of some interest and seem to supply a need.

Among the cable exhibits there were three for underground work in which multiple cored cables were subjected to 25,000 and 30,000 volts alternating, the insulation in one of these being impregnated paper without any rubber.

A German maker of aluminium goods showed that this metal can be welded without solder or flux by simply heating it to a certain definite temperature at which it softens. The use of aluminium line wires makes this simple method of interest to electrical engineers.

The number of different types of meters exhibited was about equal to the number of their exhibitors, but the Thomson meter in nearly the same form as made in this country, is the one most frequently used; several hundred a day are claimed to be made by the French company which manufactures them. The field for a good, cheap and simple ampere-hour meter for small consumers of continuous current is filled very satisfactorily in France by the O'Keenan meter, of which 11,000 are already installed. In principle it may be said to be like a d'Arsonval galvanometer or Weston instrument, in which, however, the coil is mounted so that it may revolve continuously, the number of its revolutions being registered. This coil, or armature, is a shunt to a very low resistance in the main circuit. It is extremely sensitive, and the coil requires only 0·6 microwatt to start it; it will register as little as 5 watts in the lamp circuit, or 1 per cent. of its range, has a straight line characteristic, and is not appreciably affected by temperature changes. A somewhat similar one is about to be introduced in this country, and there is, no doubt, a large field for it.

The well-known and ingenious Aron double pendulum meter was well exhibited in various forms, including one for three-phase currents. It is said to be used to some extent in Germany, but would probably not find much favour in this country.

An interesting and promising modification in the Thomson type of watt-hour meter, shown in the German section, consisted in using a three-coil armature like that in the original Thomson-Houston arc light machines; this enables the same magnetic force to be produced by a much smaller weight of the revolving part, with several attending advantages of importance.

Prepayment meters are meeting with some favour and there might also be a field for them in this country among small consumers.

In telegraphy the exhibit which seemed to attract most attention was the very ingenious printing telegraph system of Prof. Henry A. Rowland, of Baltimore. The sender merely presses lettered keys like on a typewriter, and at the other end the message is received in print on a sheet of paper ready for delivery, without requiring any operator. An alternating current of constant frequency is passed over the single line and operates synchronous motors, by means of which the necessary synchronism at the two stations is obtained. The different characters are transmitted by the suppressing of various combinations of the half waves of the current. At the receiver end these waves are received in a large number of relays, various combinations of which operate a few electro-magnets for printing the characters and moving the paper laterally and lengthwise. The typewheel revolves continuously and the paper directly beneath it is struck from below at the exact moment when the desired letter is over the paper. Four messages are sent at the same time in one direction, the line being loaned to each operator in succession for short recurring periods. This is then also duplexed, making eight messages simultaneously over one wire, each, it is claimed, at a speed of 45 words per minute. It does not seem to be used commercially yet, and whether it will be equal to or better than the printing telegraph system which has been in satisfactory commercial use between New York and Chicago for some time, devised by one of our members, can be determined only by equally severe tests.

There are several exhibits of the wireless telegraph system, though none by Marconi's company. The modifications were only in details, and did not include any way of making the system selective. It is now being introduced commercially, and there are a number of installations in regular use.

(To be concluded.)

REVIEWS.

Medical Electricity. A Practical Handbook for Students and Practitioners. By H. Lewis Jones, M.A., M.D. 3rd Edition. London: H. K. Lewis, 136, Gower Street. 1900.

We can unreservedly endorse the commendation which we were able to give to the first edition of this excellent work,* and we are pleased to see that some objections which we raised to the treatment of the subject, at that time, have been obviated in the present edition. The treatment of disease by electricity has made considerable advances even within the last few years, and these have been fully expounded by the careful revision of the whole work, and the addition of 60 fresh pages. The chapter on statical electricity, which has been rewritten and brought up to date, is of special interest, as it embodies the latest results of American practice. Several American practitioners, notably Dr. Monell, of Brooklyn, have made a special study of the medical applications of electricity derived from the influence machine, and have obtained results, in a very simple way, hitherto unknown in European practice. Dr. Lewis Jones gives a very complete account of Dr. Monell's apparatus and methods.

Chapters at the commencement of the work are devoted to introductory matters, such as the history of medical electricity, fundamental experiments and definitions. Then follow chapters on the different kinds of apparatus used, batteries, the dynamo machine, the induction coil, influence machines, and other statical apparatus. The application of the various kinds of current are expounded in chapters on physiology, diagnosis (one of the most important modern applications of electricity in medical practice), the electric bath, the treatment of specific diseases, electrolysis, cautery, and, finally, the Röntgen rays. An appendix is added containing lists of towns and districts with continuous and alternating current supplies, in view of the great advantage which results from being able to use a public supply instead of batteries for electro-medical treatment, but this even already is out of date, owing to the rapid progress which is at the present time being made in the erection of new installations.

We do not profess to be able to criticise the medical side of Dr. Jones's work, though it appears to us to be very interesting, modest in its claims as to what electricity can do, and therefore probably a thoroughly reliable guide to the medical practitioner. The electrical side of the work is also characterised by a clearness, conciseness and accuracy unusual in works of this class written by medical men. There are, however, still certain blemishes in this part of Dr. Lewis Jones's work, which in the exercise of our critical functions we feel called upon to point out.

Some of these mistakes are so obvious that they are evidently of the nature of what the lawyers call errors *per incuriam*. For example, in discussing electrolysis, the author says (p. 40):—"The ions in the case of water are hydrogen and oxygen; the former is electro-positive, and therefore appears at the kathode, or negative pole, and is called the kation, while the oxygen appears at the anode and is called the anion." Now, this describes an impossible experiment; pure water has never been electrolysed, and therefore has no ions. From some data given by M. Meylan (p. 288) a calculation is made which makes the resistance of the patient in an electric bath 1,060 ohms, and the resistance of an equivalent bulk of water 736 ohms. The data are:—Resistance of water and patient, 136 ohms; resistance of water only, 156 ohms; resistance of water only when equivalent bulk has been added, 138 ohms. Now the resistance here is 2 ohms greater when the patient has been replaced by an equivalent bulk of water, and therefore the resistance of the equivalent

* Electrical Review, Vol. 32, p. 443.

bulk of water must be greater than that of the patient. We make it 1,196 ohms; Dr. Jones makes it 736 ohms, and, unfortunately, proceeds to reason from this erroneous calculation as to what proportion of the current passes through the patient. The definition of the electro-chemical equivalent (p. 41) also appears to require correction.

Medical writers on electrical subjects almost invariably fail to give a correct explanation of the action of the induction coil. The failing, we must confess, is not confined to medical writers, but owing to the close connection of the form of the variation of a current with its physiological effect, one would expect that medical electricians would take the greatest pains to be accurate on this subject. Unfortunately a few mistakes in the theory of the induction coil appear in Dr. Jones's work. He says (p. 106): "The primary current is, therefore, a series of impulses or waves, all passing in the same direction and corresponding in time and frequency to the interruptions of the contact breaker; each wave is due to a sudden rise of electromotive force in the wire, followed by a more gradual fall, the whole time of each wave being a very small fraction of a second, and varying considerably in different coils." Now if medical coils are fitted with condensers, the currents of the primary will not all pass in one direction, for as soon as the break has taken place, the primary coil and condenser form a system having self-induction and capacity, a condition which leads to electric oscillations in the primary. Again, it is difficult to understand what is meant by saying "each wave is due to a sudden rise of electromotive force, followed by a more gradual fall;" the electromotive force in the primary is that of the battery till the break takes place, then it rises suddenly owing to the self-induction, it then reverses and rises to an almost equal amount in the opposite direction, and this takes place several times till the oscillations are damped out. But the important fact to consider in the primary of an induction coil is not the electromotive force but the current. After the break is closed the current in the primary gradually increases at a rate determined by the electromotive force of the battery, and by the self-induction and resistance of the primary coil; when the break is open the current suddenly falls to zero, and it is this sudden fall of the primary current which produces the highest E.M.F. in the secondary. The E.M.F. due to the comparatively slow increase of the current which follows the closure of the break is so small that it is only capable of producing a spark of a few millimetres in the secondary of large induction coils. Under ordinary circumstances it is the secondary current which is unidirectional, not the primary. Of course the secondary current may be alternating when the resistance of the human body is the only external resistance in circuit, but even in this case the current is probably always much greater in one direction than in the other. The only reliable method of finding the current curves from a medical coil is to trace them while being applied to the patient by some such apparatus as the Braun's tube.

In discussing the curious physiological effects of high frequency currents, Dr. Jones points out that though no shock is felt when the hands are in good contact with the electrodes, yet if there be an air gap in the discharging circuit, the shocks at once become severe, and the wider the gap the more severe are the shocks. In his attempts to explain this and other curious physiological effects of these currents, Dr. Jones has, we think, forgotten to take into consideration a very important property of rapidly alternating currents, namely, the fact that they tend to concentrate on the surface of conductors, and the greater the frequency of the alternations, or the conductivity of the conductor, the greater the concentration of the currents on the surface of the conductor. The introduction of an air gap is the introduction of resistance, which would cause the currents to penetrate into the substance of the tissues instead of flowing along the surface. Whether this be the true explanation or not, it is a point that ought not to be overlooked in investigating the subject.

Though we have devoted so much of our criticism to pointing out some defects in the electrical part of Dr. Lewis Jones's work, it must not be forgotten that these remarks apply to only a small part of the work. The descriptions and discussions of apparatus are, as a rule, excellent, and the fundamental principles of electricity are expounded with great clearness and accuracy. All the latest applications of electricity, down to the Röntgen rays, can be found clearly explained in this work, and we do not think the student or the medical practitioner will be able to find a better written and more reliable work on this interesting and progressive branch of the healing art.

The Management of Dynamos. By G. W. Lummis-Paterson. London: Crosby Lockwood & Son. 1900. Second edition.

This is a revised and enlarged issue of a work first published in 1895; it embraces a brief outline of the theory of the dynamo, so far as is necessary to its intelligent management, and a description of the details of various types of machines used in practice. More than half the volume is devoted to a very full and complete guide to the regulation, coupling, and running of dynamos, and to the methods of diagnosing and localising various kinds of faults and difficulties, commonly met with and otherwise. A useful chapter on motors has been added.

The book is thoroughly practical, though some of the troubles described are of a nature that cannot be dealt with except by radical alterations in the design of the machine, and others, as hinted above, are not very likely to occur.

Errors and mis-statements are not entirely absent. For example, on p. 4, electrical current is said to be "analogous to the *volume* or *quantity* of water" flowing through a pipe, instead of the rate of flow; and on page 12 occurs the phrase "the energy given off is first measured in watts . . . . and afterwards converted into horse-power." Akin to the latter error is the use of the word "unit" in connection with the output of dynamos—*e.g.*, "a 100-kilowatt or a 100-unit machine." What is the matter with the term "kilowatt," that it should thus be mis-named? Fig. 22, representing a drum armature with two coils wound, is incorrectly drawn, and the explanation on p. 55 of the causes of sparking is decidedly crude. On p. 95 the characteristic curve of a shunt dynamo of the conventional (and obsolete) form is given—when will this disappear from the text-books? On the score of connections, the author speaks somewhat loosely; it is not correct to say that no mistake can be made in coupling up a machine of the single-bobbin type (p. 110). Again, speaking of accidental reversal of magnetisation, the author says (p. 180) that the machine will not excite until the field connections are reversed, or until a current is sent through the field coils, so as to produce the correct polarity; this is all wrong—the dynamo *will* excite, but with the wrong polarity.

Solenoid is repeatedly spelt "solonoid," for some reason. We are not aware that central station engineers judge the voltage of an in-coming dynamo, when paralleling, by the appearance of its pilot lamp, nor that serious results occur if the speed of an out-going machine is lowered so far as to cause it to motor—both of which statements are put forward.

Most of the defects which we have noticed, however, are of minor importance, and do not seriously detract from the value of a book which should be of great use to mechanics in charge of dynamos, and to students.

ELECTRICITY ON STEAM RAILWAYS.

An interesting application of electricity to conditions similar to those prevailing on a railway has just been completed in Germany on a local line running from Berlin to outlying suburbs. Not only is the system interesting because it is running long trains similar to a steam railway, but the electrical details have some interesting, if not original, features. The system is a third rail which is placed above the surface of the rails. It is composed of iron, and has a considerable cross-section, and at joints is connected by means of solid copper connections. At each end of the line batteries have been installed in order to equalise the load. There is a motor car at each end of the

train, and when fully loaded the train can carry 410 persons, and has a total weight of 220 tons. On the level it can attain a speed of 55 kilometres an hour. The motor cars are equipped with three series motors, and the starting current is stated not to exceed 200 amperes. Some very important data may be shortly expected from the erection of this line, because the officials to the State are anxious to obtain exact data as to the cost and advantages of the electric system as compared with the steam train travelling over the same road. In order to give accurate results, the following measurements are made :—

(*a*) In the station (1) automatic registration of the watt-hour consumption ; (2) the terminal pressures at the generators simultaneously with the measurement of the pressure at the feeding point, so as to determine the drop of pressure on the feeder.

(*b*) In the cars (1) watt-hour consumption and speed diagrams between two stations ; (2) current strength and voltage and load diagrams while starting and during the period of braking ; (3) the same measurements during electric braking ; (4) determining the lateral movement of the car ; (5) ascertaining the jolting produced in the train when the current is varied or the motors are shut off ; (6) determining the wear of the wheel rim on the axles carrying the motors.

(*c*) In the battery :—The current consumption.

(*d*) In general :—(1) Maintenance cost of the line, the battery and the total electric train equipment ; (2) lubricating material ; (3) cost of electric illumination of train ; (4) cost of heating ; (5) salaries and extra money made by the motor men, conductors, and battery caretakers ; (6) the cost of maintenance of train exclusive of the electric equipment.

These details are taken from the notes of the German correspondent to the *Street Railway Journal*.

LONG DISTANCE HEAVY ELECTRIC RAILWAYS.

By RANKIN KENNEDY.

This subject is becoming almost fascinating. The tendency seems to be towards a three-phase system for the sake of easy transforming. But the three-phase motor is not controllable sufficiently easily as to speed, hence the proposal requires the use of rotary converters. These are all right, but introduce great cost and attendance at sub-stations.

The best system seems to be an alternating primary supply, it matters little whether it is single-phase or multi-phase, at a very high pressure, 20,000 volts or more, feeding stationary transformers, along the line 10 to 1 ratio, a secondary overhead trolley wire at 2,000 volts, feeding a locomotive carrying two rotary converters converting the 2,000-volt alternating to 400 or 500-volt continuous, this 500-volt continuous to work motors on each locomotive axle by ordinary controllers. Or even 100-volt continuous might be used, and 50 large storage cells carried on each locomotive, capable of moving without the trolley, while these cells could be kept charged from converter. The converter should be a very high speed synchronous motor connected to a continuous current generator.

These means would require attendance only where attendance must be, that is, at both ends of the system, the generating end and the consuming end, while the losses would be a minimum in transmission.

A single-phase system seems to be the simplest for the purpose. The battery would save all complication at crossings, junctions, round houses, and so on, as it would save overhead wires for moving the locomotives when changing, shunting, and going on and off duty.

The field of the generators and motors on the loco. would be better excited from the battery, then by keeping the motor fields constant, and by varying the generator fields by rheostat, perfect regulation can be most economically obtained without any trouble. This system of field regulation is due to Mr. Ward Leonard, I believe.

No system which is not under the most perfect control by unskilled men can be considered as practical ; speed control has not yet been possible with alternating motors of any kind.

CURRENT SPECIFICATIONS.

XLI.—WORTHING SWITCHBOARD.

Summary.

Extent of Contract.—Supply and erection of a direct-current low-tension switchboard at the Worthing central station.

Type of Switchboard.—To be suitable for a three-wire system having 460 volts between outer conductors ; three dynamos, each wound for connection across outers ; three feeder circuits, one balancing transformer, one battery of cells, and two motor boosters.

System of Cell Charging.—Only discharge switches to be provided, the cells being charged when disconnected from the bus bars.

Type of Ammeters.—"Weston" manufacture, edgewise pattern, except in the case of the one on the earthing circuit.

Type of Voltmeters.—"Weston" manufacture, six with illuminated dials, one of ordinary pattern.

Design of Board.—Blueprints showing proposed design, plan of connections, and details of shunt regulating switchgear and resistances are supplied with the specification.

Connections.—All connections between machines and switchboard to be supplied, but not those between cells and regulating switches.

Class of Cable.—To be insulated with pure and vulcanised rubber to a minimum insulation resistance of not less than 1,000 Ω per mile protected by stout braiding.

Specified Date of Completion.—May 31st, 1901.

Penalty for Late Completion.—£10 per week.

Specified Period of Maintenance.—12 months from date of completion.

Stipulations as to Removal of Foreman.—On whole satisfactory ; see comments below.

Stipulations as to Wages Paid to Workmen.—Satisfactory.

Specified Terms of Payment.—75 per cent. on delivery of whole of materials, 20 per cent. when plant is taken over by Corporation, 5 per cent. at end of period of maintenance.

Arbitration Proposals—Satisfactory.

Date for Receipt of Tenders.—December 31st, 1900.

This specification has been compiled by Messrs. Burstall and Monkhouse, the consulting electrical engineers to the Corporation, in a very thorough manner, and it embodies in its general arrangements the results of actual practice. Contrary to usual custom, the cells are disconnected from the bus bars during the period of charging, this arrangement dispensing with the necessity of employing two charge and discharge switches, and permitting the use of two simple multi-contact discharge switches. All the main dynamos are wound for the voltage across the outers of the distributing system ; the cells and a balancing transformer rectify the varying pressure in the distributing network which would otherwise be caused by the current in the neutral wire. Provision is made for suitable paralleling arrangements for use when a series winding is added in the future to the dynamos to render them suitable for traction work. Ordinary fuses are specified for one pole of the dynamo circuits and maximum current cut-outs fitted with magnetic blow-outs for the other pole.

The general conditions are on the whole fair and reasonable. That dealing with arbitration in case of disputes states :—

"Should any dispute arise between the contractors and the Corporation or the engineers in respect to the work included in this contract, or as to these conditions, *the same shall be referred to the president for the time being of the Institution of Civil Engineers, or any person being a full member of the said Institution whom he may appoint. Any decision, interim or final, of the arbitrator so appointed shall be final*, binding and conclusive upon all parties, and may be made a rule of the High Court of Justice.

This is thoroughly satisfactory, inasmuch as it is unlimited in its scope and direct in its application.

In Clause 9 we have the usual stipulation as to omissions from the drawings or specification. These are to be supplied without extra charge, the contract being for everything needed to satisfactorily complete the work in an efficient manner. The clause reads :—

Should anything be omitted either in the drawings, specification, schedule, or measurement, or these general conditions, of which is fitting, and is usually considered necessary to be done for the completion of the works, the contractors shall execute the same as if it had been particularly specified or shown, and shall supply whatever

may be necessary to complete the whole work without any claim for payment for such omitted work.

Powers are reserved for the consulting engineers to extend the time for completion for the following reasons:—

In the event of the contractors failing to complete the work within the period given in the specification to the satisfaction of the engineers, they shall be liable and bound to pay to the Corporation, as ascertained and liquidated damages, and not as a penalty, the sum named in the specification, for each and every week, or part of a week beyond the date fixed for completion during which the work remains unfinished; and the Corporation shall be entitled to deduct the amount of damage so incurred from any money in their hands belonging to the contractors. *Provided that if the engineers shall certify that the failure to complete the work arose from causes beyond the contractors' control, such as general strikes or lock-outs, failure of other contractors employed by the Corporation to do any work which affects this contract, &c., which, in the opinion of the engineers, is sufficient, then the contractors shall be relieved, in whole or in part, as the engineers may determine, from the payment of such damages.*

This clause might well be taken as a model one where penalties for late completion are concerned; it completely protects the purchaser against wilful neglect on the part of the contractor, and at the same time safeguards the contractor from penalties due to causes outside his control. It would be found in practice that the cases in which the decision of the engineers in this matter would be disputed, and the matters carried to arbitration, would be few indeed.

The only other clauses needing attention are those relating to the powers of the engineer over the contractors' employés. They read:—

During the carrying out of all work the contractors shall keep constantly on the ground a thoroughly qualified head foreman, who will be considered to represent the contractors in their absence, and who shall be able to set out all parts of the works; but if any such foreman be found, in the opinion of the engineers, to be incompetent or inattentive, or to conduct himself improperly, *the engineers shall have power to remove him by giving seven days' notice to the contractors, and to require an efficient person to be appointed in his stead*, and a foreman so discharged shall not again be employed on the works by the contractors without the sanction of the engineers. *Only competent foremen who have carried out similar work in other town installations shall be employed by the contractors to superintend the execution of the various portions of the works.*

The engineers shall have power to remove any one or more of the workmen or labourers whom they may consider incompetent or who may conduct himself or themselves improperly, without notice, and any person or persons so dismissed shall not again be employed by the contractors on the works without the permission of the engineers.

"Should the contractors refuse or delay to appoint a foreman or workman of full and proper qualifications in the room of any such foreman or workman who has been discharged under the preceding clause, or should *the contractors refuse or delay to appoint a sufficient number of workmen according to the opinion of the engineers, the latter shall be at liberty to appoint such person or persons as they may consider proper by giving three days' notice to the contractors, and such persons are to be paid reasonable and proper wages by the contractors, and are to be employed on the works the same as if they had been appointed by the contractors, and should the contractors refuse to pay them, the Corporation shall be entitled to pay them and to deduct their wages from moneys due to the contractors, and such persons are not afterwards to be discharged without the sanction of the engineers*, and without prejudice to the foregoing; but, in supplement thereof, should it appear to the Corporation that the contractors are not carrying out the works at such a rate as to secure their completion within the time specified, *the said Corporation shall have power*, with the approval of the engineers, and *after seven days' notice* to the contractors, *to employ additional men*, or to take the work out of the contractors' hands and carry it on either by themselves or by other contractors, holding the original contractors and their securities liable to all damage and extra expense, arising from delay or otherwise, which may be incurred.

NOTE.—*The powers reserved in the preceding clause are intended to guard against difficulties which may possibly occur, but these measures will not be adopted without giving to the contractors every reasonable opportunity of remedying the evils complained of.*

The appended note is perhaps the best commentary upon the stringency of the provisions. Without this explanation and the unlimited power of the contractor to appeal to arbitration, they would be distinctly dangerous. It will be noted, first, that the foreman must have been employed on similar work on town installations previously; secondly, that the engineers claim the power to appoint additional workmen, to be paid by the contractor, in case of the number actually at work being in their opinion insufficient; thirdly, that these men cannot be dismissed during the progress of the work without the sanction of the engineers; and, fourthly, the usual powers are reserved to the engineers of under certain circumstances taking the work out of the contractors' hands and yet holding them responsible for the cost of completion. We do not consider the first stipulation necessary, since the contractor as the responsible party ought to be free to employ whom he likes; the second and third clauses are dangerous innovations; while the fourth needs very careful wording in the final contract.

As limited by interpretation and right of appeal to arbitration, they may perhaps be accepted in the present instance, but without these safeguards they should be strenuously and consistently opposed.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

21,837. "Improvements in prepayment electricity meters." G. W. Lemmis-Patterson. Dated December 3rd.

21,838. "An appliance or device for obtaining direct electrical impulses or currents from alternating electric sources." G. B. Batten. Dated December 3rd.

21,852. "Improvements in electric traction." E. H. Tyler and A. G. Hanbard. Dated December 3rd.

21,858. "Improvements in or relating to electrical contacts for detecting electrical disturbances receiving electrical vibrations or like uses." M. Cantor and The Prof. Braun's Telegraphie Gesellschaft mit Beschraenkter Haftung. Dated December 3rd.

21,860. "Improvements in electric meters." The British Thomson-Houston Company, Limited. (E. Thomson, United States.) Dated December 3rd. (Complete.)

21,861. "Improvements in controlling electric boosters." The British Thomson-Houston Company, Limited. (E. M. Hewlett, United States.) Dated December 3rd. (Complete.)

21,862. "Improvements in methods of securing pole-pieces to electric machines." The British Thomson-Houston Company, Limited. (H. G. Reist, United States.) Dated December 3rd. (Complete.)

21,880. "Improvements in or relating to electrical governing or controlling apparatus." E. F. Moy and P. H. Baster. Dated December 3rd.

31,886. "Improvements in electrical storage or accumulators." L. E. Lacroix, Jun. Dated December 3rd.

21,903. "Improved means of holding the inner glass and lower carbon of an electric arc lamp." F. J. Green. Dated December 3rd. (Complete.)

21,904. "An arrangement of electrical resistance, especially adapted for electric arc lamps." F. J. Green. Dated December 3rd.

21,909. "Improvements in and connected with wireless telegraphy." A. Blondel. (Date applied for under Patents, &c., Act, 1883, Section 103, May 3rd, 1900, being date of application in Belgium.) Dated December 3rd. (Complete.)

21,922. "Automatically controlling the speed at which electric tramcars, motors and the like may be driven." R. F. Collings and H. H. Lisdon. Dated December 4th.

21,948 "Improvements in electric arc lamps." Crompton & Co., Limited, A. J. Hodgson, and J. W. Ewart. Dated December 4th. (Complete.)

21,961. "New or improved self-acting electric fire alarm and signalling device." F. Gulting. Dated December 4th.

21,963. "An improved adjuster or height regulator and cord receiver for electric lamps and like purposes." H. McGowan. Dated December 4th.

21,991. "Improvements in connections for electrical conductors." W. B. Cleveland. Dated December 4th. (Complete.)

22,010 "An improved method of connecting electrical conductors." W. B. Cleveland. Dated December 4th. (Complete.)

22,019. "Improvements in storage batteries." A. Meygret. Dated December 4th. (Complete.)

22,021. "Improvements in arc lamps." J. Velle and The Mercury Cycle Manufacturing Company, Limited. Dated December 4th. (Complete.)

22,022. "Improvements in or relating to secondary or storage batteries or accumulators." A. J. Boult. (L. Sauvan, France.) Dated December 4th.

22,026. "Improvements in electric wave telegraphs." A. J. Boult. (American Wireless Telegraph Company, United States.) Dated December 4th. (Complete.)

22,068. "Improvements in the construction of instruments for the measurement of electrical energy." A. C. Heap. Dated December 5th.

22,098. "Improvements in the production of electric light." J. W. Graydon and J. O. Egestorff. Dated December 5th.

22,118. "A new or improved endless electric conveyer for conveying tin plates from the bath of molten metal to a suitable or desirable place." J. Haxter, O. Clark, and C. Hillman. Dated December 5th.

22,126. "Improvements in apparatus for wireless telegraphy." J. A. Fleming and Marconi's Wireless Telegraph Company, Limited. Dated December 5th.

22,142. "A new or improved telephone relay." E. S. Hagemann and V. Poulsen. Dated December 5th. (Complete.)

22,182. "Improvements in or connected with electrical contact makers or switches for use at the insulated junctions of sections of electrical tramways and railways and for analogous purposes." H. G. Nicholson. Dated December 6th.

22,196. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (E. Thomson, United States.) Dated December 6th. (Complete.)

22,197. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (E. Thomson, United States.) Dated December 6th. (Complete.)

22,230. "Improvements in or relating to electric cables or conductors." W. J. Glover. Dated December 6th.

22,233. "Improvements in or relating to electric railways, tramways, and the like." C. Kando. Dated December 6th. (Complete.)

22,234. "Improvements in or relating to automatic electrical relays for operating pneumatic brakes in electrically-propelled vehicles and the like." C. Kando. Dated December 6th. (Complete.)

22,240. "Improvements in the electrolytic refining of metals." S. Cowper-Coles. Dated December 7th.

22,253. "Improvements in and relating to electric switches for use in controlling motors." E. T. Parker. Dated December 7th.

22,272. "Improvements relating to galvanometers, voltmeters, and like apparatus." T. E. Gambrell and C. T. Gambrell. Dated December 7th.

22,273. "Improvements relating to electrical plug resistance boxes and like apparatus and to switches therefor." C. T. Gambrell and T. E. Gambrell. Dated December 7th. (Complete.)

22,281. "Improvements in the means for suspending electroliers, electric lamps and the like." E. Fletcher. Dated December 7th.

22,285. "Improvements in current collectors for electric vehicles." The British Thomson-Houston Company, Limited. (S. B. Stewart, United States.) Dated December 7th. (Complete.)

22,286. "Improvements in electric switches." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated December 7th. (Complete.)

22,287 "Improvements in synchronizing apparatus for electric alternators." The British Thomson-Houston Company, Limited. (F. T. Dow, United States.) Dated December 7th. (Complete.)

22,288 "Improvements in means for attaching pole-pieces to electric machines." The British Thomson-Houston Company, Limited. (H. G. Reist, United States.) Dated December 7th. (Complete.)

22,290. "Improvements in telephone and telegraph apparatus." S. G. Brown. Dated December 7th.

22,313. "Improvements in manufacturing laminated cores for electrical apparatus." A. N. Thorin. Dated December 7th.

22,316. "Improvements in or relating to electric cables or conductors." W. J. Glover. Dated December 7th.

22,360. "Improvements in wireless electric telegraphic and audible signals, particularly applicable to ships and coast points." P. A. Cain. Dated December 8th.

22,362. "Improvements in the construction of inductors." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated December 8th. (Complete.)

22,372. "A method and apparatus for discharging electrified wool." J. G. White & Co., Ltd., and J. G. White. Dated December 8th.

22,378. "Improvements in drying apparatus for use in the manufacture of electrical insulating materials." E. A. Claremont. Dated December 8th.

22,379. "Improvements in apparatus for the manufacture of electrical insulating materials." E. A. Claremont. Dated December 8th.

22,401. "Improvements in the manufacture of illuminating bodies for electric lighting." E. Sander. Dated December 8th.

22,403. "Improvements relating to electric lighting on railway trains." J. Woodside and F. Wilson. Dated December 8th.

22,406. "Improvements in the decomposition of alkaline salts by electrolysis and in apparatus therefor." J. Greenwood. Dated December 8th.

22,411. "Improvements in and relating to electric tramways or street railways." W. B. Sayers. Dated December 8th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

485. "Improvements in telegraphic relays." R. W. Paul. Dated January 9th, 1899. Relays of the moving coil type are arranged with a lever, carried by the moving coil having a V fork on its outer end to act as stops for an elastic tongue on the end of the contact lever. The contact lever is pivoted, and has a light controlling spring. The lever is arranged to contact with the tongue only after the coil has attained a certain momentum. All the parts are provided with adjustments, and the apparatus is built up so as to facilitate the removal of various parts. 4 claims.

516. "Improvements in telegraphic receiving and translating instruments." A. Muirhead. Dated January 9th, 1899. Relates to arrangements for working submarine and other systems of telegraphy, either singly or by duplex methods, and for translating from one cable to another. The siphon recorder employed may preferably be such as described in Specification No. 20,793, A.D. 1898, and any well-known type of relay, but preferably that described in Specification No. 10,908, A.D. 1897, may be used. Various arrangements are described of the coil, local, and bridge circuits, when duplexing; the use is also described of double or differentially wound siphon-recorder coils, and the use of a second such coil in connection with the local relay or translating circuits. Several arrangements are described for imparting a vibration to the second or main siphon coil, one form being a small alternator. When a second coil is employed, it is connected by fibres with contacts controlling the translating relay circuits. When the second coil is arranged in bridge form, the main coil may be connected to springs which by bending out in or out a number of separate resistances or may vary the amount of a continuous resistance in two of the arms of the bridge. In the case of duplexing and translating, each cable at the intermediate station is provided with the translating-devices, the currents in the second coils being overflow or curb currents, adjustable self-inductances and artificial cables being also employed. 6 claims.

571. "Improved electric arc lamp clutch and feed mechanism." H. V. James. Dated January 10th, 1899. Relates to arc lamps. The upper carbon is secured in a holder on a tube, which is passed up into a tube movable vertically by a controlling coil. The clutch consists of two india-rubber pads adjustable by screws in levers which are hinged to a loose plate, and pass in inclined directions through slots in a block clamped on the tube. Screws prevent the levers from leaving the slots. When the tube is raised, the block moves the levers inward so that the pads grip and lift the carbon carrier; when the tube falls sufficiently, the plate is stopped by a part of the frame of the lamp, opens the clutch. In modifications for enclosed arc lamps, the carbon carrier, and pads are dispensed with, the screws or plain projections on the levers acting directly on the carbon, which is inserted in a guide sliding in the tube. The Provisional Specification states that the screws may have heavy arms which bare on the lamp frame when the clutch is lowered, and which turn the screws inward against the carbon when the clutch rises. 3 claims.

635. "Improvements in electrical appliances for controlling the supply of gas to burners and effecting its ignition from a distance." C. Franzen. Dated January 10th 1899. The rotary disc or other gas valve and the incandescent or sparking igniting device are simultaneously operated from a common electro-magnet, and the leads of the igniting device are arranged within the incandescent or other burner. The igniting circuit from the electro-magnet which actuates the valve is formed by wire, the conducting connections to the igniting device and thence by connections which pass through insulating material, and a tube to the electro-magnet. The wires and the igniting device are carried by a glass tube which may be easily detached and renewed. The igniter is protected by a perforated tube which in the case of incandescent burners supports the socket of the mantle rod. 1 claim.

655. "An improved locking and releasing device for electrical switches." F. P. Cox. Dated January 11th, 1899. Relates to means for locking a switch in the "on" position. In one form the contact-arm, is rigidly connected to a sleeve to which the handle is also connected through a cap (covered with ebonite). The sleeve turns on a central tube secured to the base. Within the tube works a push fitted at the bottom with a tooth working in a groove in the sleeve. In the "on" position, the pin rises under the action of the spring into a slot, and so locks the switch. To release the switch, the push is depressed. In a modified arrangement the switch is released by a partial movement of the handle. The cap is loose, and is fitted with a pin working in an inclined slot in the sleeve, so that, on turning the handle, the cap moves vertically, so depressing the push-piece, which does not, in this case, pass through the cap. A spring is fitted around the sleeve to give a quick break. 3 claims.

656. "An improvement in electrical switches." F. P. Cox. Dated January 11th, 1899. Relates to means for isolating the metallic central parts of a switch from the contacts. In the two forms described, a mantle or cover of inverted cap-shape surrounds the swivelling parts and moves with the contact lever. In knife switches and the like, the contact arm carries a shield which works with a shield or projection on the base. 1 claim.

825. "Improvements in electrical measuring instruments." A. F. Harris. Dated January 13th, 1899. Relates to current meters. An axle supported between jewelled bearings in bridges on two permanent magnets or electro-magnets, carries two flat circular coils between flat pole-pieces and a pointer. Current is supplied to the coils through insulated spiral-controlling springs. The brass supports of the magnets carry a semi-circular scale over which the pointer moves. The coils are wound on copper or aluminium supports. The forms of the coils and pole-pieces may be varied to produce any desired scale. One coil and magnet may be used, the coil being balanced. The instrument is applicable as an ammeter or voltmeter. 2 claims.

903. "Improvements in telephone exchange switchboards." A. Eckstein and W. A. Guthrie. Dated January 14th, 1899. Telephone switchboards are arranged with plug socket boards provided with levers to operate contacts for cutting in and out the operator's instrument in the act of answering a call. The cord passes through the arm, and by means of the weight holds the arm down when the plug is not in use. 3 claims.

918. "Improvements in enclosed electric arc lamps." W. J. Davy. Dated January 14th, 1899. Relates to arc lamps. An enclosed arc lamp has a frame consisting of a top-piece, a plate, and a base-plate. The lower plate carries two series solenoids on the left, and a single shunt solenoid on the right. The casing carries a dashpot. The upper carbon is inserted in a socket sliding in the tube, and it passes through a clutch disc, which at one side may rest on a support below a roller and links, and at the other engages a vertically sliding rod. This rod carries the piston of the dash-pot and the core of the shunt solenoid; a silk bag connects the rod and the top of the dash-pot, to exclude dust. The shunt core is connected flexibly with a circular surface on a regulating lever, the other end of which similarly carries a U-shaped core in the series solenoids. The shunt solenoid is connected electrically through an insulated contact-spring, and a switch pivoted at its centre on a ring on the tube. The switch is operated directly by the regulating lever in its extreme positions, to disconnect the shunt solenoid when the series solenoids are carrying up current, the action of the series solenoids tending to close the shunt circuit. The lower carbon holder is clamped in the arc enclosing bell. This is held in a packed groove in the base-plate by a wire yoke, the middle of which is bent up to enter a recess in the carbon holder, while its ends are looped to two helical springs, depending from insulators on the plate, and having straight ends guided vertically in insulators on the base-plate. An outer globe is carried by a ring, parts of which rest on a slotted flange in a casing attached to the top-piece. The provisional specification states that the upper carbon socket may be coned to support metal balls, which are pressed against the tube by a heavy ball or cone, or a spring disc, to make electric connection; or the socket may carry a spring. 5 claims.

934. "Improvements in apparatus for electrically transmitting orders, signals, or indications from one place to another." A. U. Alcock. Dated January 14th, 1899. Relates to electric apparatus for transmitting orders, signals, or indications from one place to another, *e.g.*, from the bridge of a steamship to the engine room, or from the conning tower of a warship to the gun turrets. The receiver pointer is carried by the spindle of the armature, mounted within a ring-shaped field magnet, which is encircled by three pairs of coils, connected together, and to the fixed electrodes of the transmitter. The coils are spaced equidistantly on the magnet, and the electrodes are similarly mounted in a cell containing a suitable electrolyte, such as dilute acid or alkali solution, or ordinary or distilled water. The pointer of the transmitter carries two movable electrodes, which are connected by the leads to a source of electricity and move in the electrolyte. When a direct current is employed, the armature may be permanently polarised, but when an alternating or varying current is employed, the armature is polarised by a current of corresponding phase through the coil. In one arrangement, a transformer having two secondary windings is employed, the former being connected to the electrodes, and the latter to the coil. When the pointer is moved over its dial, the variations in the currents, caused by the movements of the electrodes in relation to the fixed electrodes effect an alteration in the magnetic field of the receiver, the pointer of which exactly follows the movement of the pointer. The receiver pointer may be rendered dead beat, by means, such as a magnetic brake, acting on the armature spindle. In the modification of the receiver, the field magnet is replaced by three pairs of iron cores arranged, with their axes parallel and 60° apart, within correspondingly-arranged coils. The apparatus also may be used as a speed counter, the spindle being geared to a counting-mechanism, and the movable part of the transmitter being arranged to be operated by a shaft driven by the engine, &c., the speed of which is to be indicated. 3 claims.

15,438. "A new or improved electrolytic process and apparatus for the production of chemically pure copper sulphate and copper." E. Fromet. Dated July 27th, 1899. Consists of a process and apparatus for the extraction of chemically pure copper sulphate and copper by electrolysis, consisting of an upper bath containing the electrolyte which is fed to a lower bath containing the electrodes comprising a revolving copper anode and a cathode arranged symmetrically relatively to the former distance between these two electrodes being adjustable and a vat serving for the crystallisation of the saturated electrolyte. 1 claim.

16,005. "Improvements in the method of and apparatus for manufacturing incandescent electric lamps." A. Swan. Dated August 5th, 1899. The principal feature of the invention is that the stem which carries the carbon filament is fused to the inner wall of the neck of the lamp simultaneously with the operation of giving definite shape to the neck itself. Another feature is the securing of the lamp base or shell upon the neck of the lamp simultaneously with the preceding operations. 8 claims.

16,366. "An improvement in toothed armature plates." J. Burke. Dated August 11th, 1899. Relates to a new method of making armature discs by which a more ample space for the armature winding is gained without increasing the radial depth of the notches and without decreasing the minimum mass of iron left between them. The notches are made in the form of a curve so that the notches remain of approximate equal sectional width throughout. 1 claim.

16,387. "Improvements in brush holders for electric machines." S. H. Short. Dated August 11th, 1899. Consists of a brush holding device, especially designed for street railway motors, in which the part carrying the brush holders proper is adjustable longitudinally with respect to the commutator. Combined with this are brush holders proper which are adjustable radially with respect to the commutator. 5 claims.

16,555. "Improvements in the reduction of aluminium by electrolysis." F. A. Gooch. Dated August 15th, 1899. Consists of the process of reducing aluminium by electrolysis by fusing together a suitable compound of aluminium and a suitable halogen compound of a metal more electro-positive with reference to sulphur than is aluminium, adding to the bath a suitable compound of sulphur together with alumina and then passing an electric current of suitably low voltage through the fused mass. 6 claims.

16,627. "Improvements in electric arc lamps." J. Lesthevenon. Dated August 16th, 1899. Consists of an electric arc lamp, the solenoid of which is arranged in shunt and which is operated by the weight of the upper carbon holder, characterized by the very high resistance of the solenoid, and by the arrangement of its mechanism constituting a kind of balance, the beam of which is controlled on the one hand by the core of the solenoid and the weight of the upper carbon holder, and on the other hand by an adjacent counter-weight for the purpose of producing a lamp capable of working economically at different powers. 4 claims.

16,997. "Improvements in rail bonds for electric railways and other purposes." A. J. Boult. (F. H. Daniels.) Dated August 22nd, 1899. Consists in a rail bond having a wire loop-like body provided with terminals the sides of the loop being brought together for a certain portion of their length between the terminals and being separated from one another at other points to form openings. 1 claim.